



**A Report on the work done by
the Locust Research Staff under
the Locust Research Entomologist
to the Imperial Council of
Agricultural Research at Karachi
during the year 1934.**

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A REPORT ON THE WORK DONE BY THE LOCUST RESEARCH STAFF UNDER THE LOCUST RESEARCH ENTOMOLOGIST TO THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH AT KARACHI DURING THE YEAR 1934.

By Rao Sahib Y. Ramchandra Rao, M.A., F.R.E.S., Locust Research Entomologist.

RA I. UNIVERSITY

1. *Report of the Locust Research Scheme as Locust Research Entomologist at Karachi during the year under report with the exception of a period of about three months from the 18th August to the 7th November, 1934, during which I was on deputation out of India to attend the Third International Locust Conference held at London in September, 1934. During this period, Dr. K. R. Karandikar, Ph.D., F.R.E.S., was placed in charge of the work in addition to his own duties as Assistant Locust Research Entomologist, Pasni.*

2. *Ecological Staff.*—Dr. K. R. Karandikar continued to be in charge of the ecological work at Pasni and Ambagh Field Research Stations with headquarters at Pasni. Mr. Atul Chandra Sen, M.Sc., Locust Research Assistant, worked at the Pasni Field Research Station, throughout the year while Syed M. H. Taqi Ahsan, M.Sc., who was appointed Locust Research Assistant in April, 1934, was placed in charge of the work at Ambagh.

The Locust Survey Staff. 1. *Khanpur Circle* with headquarters at Khanpur, Bahawalpore State. Mr. Keshodas Baweja, M.Sc., was, as in the previous year, in charge of the survey work in Dera Ghazikhan, Bikaner and north Jaisalmer desert areas, with two Fieldmen stationed at Khanpur and Bikaner respectively under him. As recommended by the Locust Committee in January, 1934, a new Field Observation Post was opened in July, under the orders of the Imperial Council, at Sardarshahr, in Bikaner State, with a Fieldman working under the supervision of Mr. Keshodas Baweja attached thereto, for the purpose of carrying out intensive survey work roundabout and of recording meteorological data throughout the year.

2. *Mirpurkhas Circle*—(Headquarters changed recently from Mirpurkhas to Hyderabad (Sind) in October 1934). Mr. Desraj Bhatia, M.Sc., continued to be in charge of the survey work in Sind, south Jaisalmer, South Marwar and Cutch areas with two Fieldmen under him stationed at Rohri and Mirpurkhas. As decided by the Locust Committee, a new observation post was opened in the centre of the desert area at Chachro from May 1934 under the supervision of Mr. Bhatia, with two Fieldmen attached thereto for attending to intensive survey work roundabout and to the recording of meteorological data.

3. *Mekran-Lasbela Area.*—The four observation posts at Gwadar, Ormara, Turbat and Sonmiani continued to function throughout the year under the general control of Dr. Karandikar. The observation post at Sonmiani was attached to the Field Research Station at Ambagh. The supervision of the survey work in Mekran and Lasbela areas was, as decided at the meeting of the Locust Committee in January, 1934, delegated to Locust Research Assistant, Mirza Ahmad Ali Khan, stationed at Karachi.

Compiling Staff.—Mr. Chandar Parkash, B.Com. and Mr. Shantilal continued to work as Compiling Assistants throughout the year.

II.—ITEMS OF LOCUST RESEARCH WORK IN PROGRESS DURING THE YEAR.

1. *The Ecological Study of the Solitary Phase Locust.*—A. Pasni : as centre for the winter-rainfall areas of the Mekran Coast.

B. Ambagh (Sonmiani) : as centre for the summer rainfall areas of the Mekran Coast.

2. *Distributional Survey of the Locust Areas—*

A. Khanpur Circle : Survey work in Dera Ghazikhan, Bahawalpore, Bikaner, north Jaisalmer and surrounding areas.

B. Mirpurkhas Circle : Survey work in Sind, Kachhi, south Jaisalmer, Jodhpur, Cutch and neighbouring areas.

C. Ambagh Circle : Survey work in the Lasbela Area.

D. Mekran Circle : Surveys in Panjgur, Kolwah, Kech, Dasht, Kulanch and the Coastal Reks.

3. *Study of Locust Movements during the year.*

4. *Study and Compilation of Old Locust Records ; Mapping the Locust Data.*

5. *Study and Correlation of Meteorological Data.*

6. *Study of the Fauna and Flora collected ; and of the Locust Collections.*

III.—SURVEY WORK.

Tours.—As in 1933, more or less regular beats were arranged for the Fieldmen in the areas allotted to them so that all the places important from the point of view of locusts might be visited 3 or 4 times during the year, so as to note the effect of the seasons on the locust population. The Assistants usually joined them on alternate tours.

At the Field Research Stations at Pasni and Ambagh, and at the Desert Observation posts at Chachro and Sardarshahr, regular intensive surveys were made within a radius of about 5 to 10 miles. At the Observation Post at Gwadar also, the Field man made regular periodical surveys of the "reks," while at headquarters. In addition, longer surveys of about 50 miles' radius were also periodically undertaken at Chachro, and as far as possible around Sardarshahr (considering the limited staff there).

In addition to the ordinary beats, the following long tours were carried out by the Survey Assistants accompanied by the respective Fieldmen :—Mr. Keshodas Baweja : (1) A tour from Anupgarh in Bikaner State right across the deserts of Bikaner, Jaisalmer and Sukkur, *via* Pugal, Barsilpur, Nachna, Mohangarh, Jaisalmer, Khuiala, Shahgarh, Piarawaro Tar to Rohri in February—March 1934, and another, (2) across the Shekhawati desert in Jaipur State from Sikar to Churu in September. Mr. D. R. Bhatia visited all the desert areas in Thar-Parkar and South Marwar in February—March, and toured in Cutch twice, once in May and again in October. Mirza Ahmadali Khan travelled from Karaehi to Bela, thence on camels across South Jhalawan *via* Goko Pat and Nundara to Awaran, and thence toured in Kolwah Panjgur, and Kech areas by motor-lorry kindly supplied on hire by the Assistant Political Agent, Mekran, April—May 1934.

Owing to illness, some of the Fieldmen were absent on leave for considerable periods, and since it was not possible in many cases to find substitutes in their places, some of the projected tours could not be carried out.

Statement A—I, II, III and IV—contains lists of the tours actually carried out during the year in the different circles all of which have been serially numbered for reference.

Results of Locust Surveys.—The results of the various tours have been tabulated and presented in *Statement B*. In these tables, only those places where locusts were encountered have been included, and the date of collection and the numbers noted have been shown. The results have, moreover, been classified according to the seasons, so that the effect of the seasons on the locust population is fairly clearly seen. Figures for Mekran and Lasbela Reks have been included in *Statement B*-(1), while those for the Mekran Hinterland in *B*-(2), for the northern desert areas of N. W. India (mostly Khanpur Circle) in *B*-(3), and for the southern areas (mostly Mirpurkhas Circle) in *B*-(4).

Before discussing the results of these surveys, the character of the seasonal rainfall in 1934 might be first briefly reviewed, since rainfall is an important factor in locust economy.

Weather in the Desert Regions of N. W. India in 1934.

Winter-rainfall.—During the winter and spring season of 1933-34, 53 western disturbances passed from the direction of Iraq, over Persia, the Persian Gulf Region, Baluchistan and N. W. India between October 1933 and the first week of June 1934, but did not result in effective rainfall except in a few places. Along the coastal areas of the Persian Gulf and Mekran, there was very little rain, except in the Jask sector of Persia, where 5 inches of rain fell in March, and roundabout Bahrein and Sharjah. In British Mekran, some rain was registered in the interior of Mekran in March, while none was recorded on the 'reks' of the Mekran coast.

In the areas of the Indian Desert, scattered thundershowers appear to have fallen over the Jaisalmer and Bikaner areas, and to a smaller extent in the Thar-Parkar desert, during the second and third weeks of March. While at Bikaner the rainfall in March measured only about $\frac{1}{2}$ inch in all, Hissar at the eastern fringe of the desert received about $4\frac{1}{2}$ inches in that month. As thundershowers are sporadic in occurrence and vary in intensity from place to place, it is not improbable that some heavy falls might have occurred in parts of the desert. There was some rainfall in the Dadu-Larkana area also about the same time.

On the whole, there was a serious failure of winter-rainfall in the Mekran area.

Summer-rainfall.—During the pre-monsoon period, there was but little rain-fall, and very high temperatures were recorded in the first fortnight of June in the desert areas, but the monsoon extended into Western Rajputana, Sind and Lasbela rather early. Good showers were received in the last week of June and the first week of July. There was a considerable break later on in July, but in August heavy rains were received in Rajputana, and though they did not make their influence very much felt in Sind and Lasbela, some good showers appear to have fallen in the hinterland of Mekran in Panjgur and Kolwah. The monsoon withdrew rather early and there was very little rainfall in the desert areas in September.

Results of the Survey Work in 1934.

In examining and comparing the statements of locust findings in different parts of the locust areas and at different seasons, it may be stated that the figures of locust finds noted therein serve merely to give an index to the relative density of the visible locust population. They cannot, however, be considered to give any absolute values. Negative results do not mean that locusts are entirely absent, but only that they were not noticeable, and, therefore, they do not have the same values as actual finds, which are positive data in regard to locust occurrence. Most of our surveys have been of the extensive kind, and though intensive surveys would have been more valuable in furnishing data, they could not be undertaken on account of the vastness of the areas to be covered.

The values of the results of surveys have also to be judged by the following considerations :—(1) In the cold season, locusts are not active except at mid-day. (2) In cloudy weather and when heavy winds prevail, they usually retire into the interior of bushes. (3) In summer, when the weather is very dry and hot, they seek shelter from the sun in the shade of bushes, and are not easily detected. Hence the low counts or negative results recorded in really cold weather or during unfavourable weather conditions would not be of much significance.

Locusts—in their non-gregarious condition—are usually to be found scattered over a large area, and if good numbers are to be seen at any particular place, the concentration may be brought about in connection with pairing and egg-laying, or less usually for feeding, or may be an indication of the recent development of a new brood.

1. *Breeding in Winter-rainfall areas.*—No indications of breeding were noted anywhere on the Ormara, Pasni, Gwadar, and Pishukan Reks, and observations made by the survey staff show that locusts did not breed anywhere in the hinterland of Mekran, e.g., Dasht, Kulanch, Kech, Kolwah or Panjgur. This is clearly attributable to the failure of winter and spring rains in these areas, vide Statements (C) & (D).

There was no summer rainfall of any consequence on the coastal 'reks' westwards from Ormara. The interior of Mekran, on the other hand, appears to have had, to some extent, an extension of the influence of the monsoon, appreciable rainfall being reported from Panjgur and Kolwah in June and August. Whereas very few locusts were noticeable in Kolwah, Panjgur and Kech in April and May, a fair number was seen in Kolwah in July, in the Panjgur area in August and November, and in the Kech valley in July and November. It is difficult to say definitely whether any summer breeding had occurred in these areas, but the general indications are, however, that it had taken place to a small extent.

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2. *Breeding in summer-rainfall areas.*—In the Lasbela area no spring brood was noticed in the places surveyed. In western Sind, the Fieldman reported that he had found a few yellowish and some pinkish specimens of the locust in the Dadu district in April. Since a few showers had been received in this area in March, it is possible that some breeding had occurred here. In the Rajputana region, a rise in population was noticed in the Pugal-Bikaner area of Bikaner and in the Nokh-Baru area of Jaisalmer in May and June. The specimens collected were straw-yellow in colour and were probably of the

new brood developed in spring, but they had already assumed a yellow tinge in their hind wings. It is possible that they had developed from eggs laid in these areas after the fall of thundershowers recorded in March.

With an early extension of the monsoon into Rajputana, Sind and Lasbela, breeding commenced in these areas by the end of June. Green hoppers were noticed in July around Chachiro and in the Ambagh-Naka Kharrari area, and continued to be found throughout August. The new brood adults were noticeable early in August. Around Bikaner, at Derawar in Bahawalpore State, and in Thar-Parkar desert generally, although hoppers were not detected, the adults of the new brood were found during August. In the Dera Ghazikhan area Mr. Keshodas found green hoppers in small numbers in sandy areas near Dera Ghazikhan, Taunsa and Tibbi Karsani, mostly on bushes of *Aerua javanica* (loc. name. 'Boo'), as was the case also around Chachiro. While in Lasbela and the Indian Desert generally, the breeding occurred as early as June, in Dera Ghazikhan it took place in October, which was the case in 1933 too.

On the Ambagh-Naka Kharrari reks, breeding in 1934 was, as compared with that of 1933, earlier but of a more limited extent. While in 1933, the locust population had increased very greatly by October, the increase was comparatively small in 1934. In the Hingol area, especially near Pohr, an increase in numbers was noted during the surveys made by the Fieldman in September and November, but hoppers had not been looked for nor had the condition of the adults been noted. Here is another instance where the proper supervision of a Survey Assistant would have been of value.

3. *Number of generations in the year.*—While on the coastal Reks in Mekran there was no breeding whatever during the year, in the interior of Mekran, the available data give vague indications of a limited summer breeding. In the Lasbela area, breeding occurred in summer and was definitely limited to a single generation, which appears to have been the case in general in Bahawalpore, Dera Ghazikhan and Thar-Parkar.

In parts of Bikaner and Jaisalmer and in Dadu district, limited spring breeding appears to have taken place, in addition to which a fair amount of breeding occurred in Bikaner and east Jaisalmer during the monsoon period, two generations of the locust having thus occurred in this area this year.

In the course of intensive work around Chachiro, Mr. Bhatia records that he had found hoppers in the field (*vide* Statement G), as late as the first fortnight of October, and has suggested that these might represent the second generation of the locust, produced by the earliest adults of the first generation emerging in August and becoming mature by the end of that month. Though this need not be deemed to be outside the range of possibility, the fact that he found the adults of the old generation persisting till the end of August indicates that the hoppers in question were more likely to have been the progeny of some of these adults.

4. *Migration among Solitary Phase locusts.*—During the year under report, no definite evidences of migration among the non-gregarious locusts were noted. There were some indications that local migrations had taken place during the year in certain peculiar situations, as for instance, from the desert-fringes into the interior of the desert, and *vice versa*.

At Chachiro, and generally in the whole of Thar-Parkar district, no locusts had been noticed during surveys in March and April. At Chachiro the first locust specimen noticed was found on the 19th May, and five more were collected during June. With the onset of the rains, larger numbers were found

during July at Chachro, but very few were noted in certain parts of the Thar desert, such as Mithi and Diplo talukas. It is not clear whether the locusts found after May are to be considered to be immigrants from outside or to have emerged from hiding in bushes with the seasonal rise of atmospheric humidity in May. Possibly further intensive surveys may give definite clues to a solution of this question.

Mr. Bhatia mentions in his report for August, 1934 that a heavy wind storm had occurred at Chachro on the 12th August coming from the south-eastern direction, and that in the course of surveys carried out after this date 13 specimens of locusts of a bright yellow colour were collected along with others of the usual grey colour. He suggests that these might have belonged to small swarms of the gregarious phase that had been carried in by the wind. A biometrical examination cursorily made has, however, shown that the yellow specimens do not possess any marked *gregoria* facies.

In the case of the Mekran reks, the locust population of the reks, especially of Gwadar, Pishukan and Hingol, had increased in April—May, in spite of the absence of breeding, while in the hinterland very few locusts were noticeable at this time. On the other hand, with the fall of rain in the interior in June a decrease in number is to be seen on the coast as well as a certain degree of increase in the hinterland. This possibly may be interpreted as being an indication that general movements of the solitary locusts were possibly afoot at these times. In this connection it may be recalled that under more or less similar conditions in May 1932, an incursion of scattered yellow and pink locusts from the interior of Mekran into the Pasni Rek had been recorded. Definite information about such movements may possibly be obtained by liberating coloured locusts on the reks and noting the date and place of their re-capture.

5. *Other locusts*: 1. *Patanga succincta*.—A few specimens of the Bombay Locust were collected near Mandvi in Cutch as in 1933.

2. *Locusta migratoria* ph. *solitaria* was observed all over the desert areas in small numbers and was collected also from certain places in the Punjab and Sind. Mr. Bhatia reports that he found hoppers of this species in the neighbourhood of Rahim-ki-bazaar in Thar-Parkar district. It might be interesting to observe whether this species would be affected by the more moist conditions brought into existence in Sind and the Punjab by the new irrigation systems.

3. *Anacridium aegyptium* and *Cyrtacanthacris tatarica* were found in small numbers in many places by the survey staff.

IV.—ECOLOGICAL STUDIES.

1. *Pasni Field Research Station*.—As instructed plans and estimates were prepared and tenders called for, for the erection of the buildings sanctioned for housing the laboratory and the Research staff on the Pasni Rek. Construction will be begun as soon as final sanction is obtained.

As suggested at the last meeting of the Locust Committee, a large wooden cage fitted with copper wire-gauze was prepared and sent to Pasni in July. It was designed with the help of plans received from Mr. P. B. Richards, Government Entomologist, Cawnpore and was constructed as two independent units each 33 ft. long, 16½ ft. broad and 6 ft. high, and partitioned in the middle to form two equal compartments 16½ ft. square. The cage has been so made as to be capable of being dismantled and set up without much difficulty at a different place, if required later on. The total cost of the cage has amounted

to about Rs. 1,600, but it should have cost less had it not been damaged by the roughness of the seas at the time of unloading on the Pasni Roads, so that the wire-gauze had to be replaced in several places. It has now been set up on the Pasni Rek, but as the vegetation had dried up everywhere owing to the drought, the bushes inside the cage had to be watered specially. As there was no supply of locusts available in the field, reared locusts had to be introduced for starting observations.

Detailed results of the ecological studies are included in the report of the Assistant Locust Research Entomologist, and my remarks will be confined to a few general observations on the experiences of the year under report.

Locust breeding was not observed anywhere on the reks during the year owing to the failure of both winter and summer rainfall. Though the initial population of locusts was fairly high, the numbers diminished gradually until at the end of the year none could be seen at all. In the cages, however, the desert locust went through four generations during the year under semi-natural conditions, by reason of the provision of moist sand at the bottom of the cages. At Gwadar, the latest period when hoppers were observed was in July 1933, and since a few adults were noted as late as October on Gwadar and Pishukan reks, it may be surmised that the longevity of an adult locust may extend up to 15 months, unless indeed they happen to prove to be immigrants from the interior of Mekran.

On account of the prevailing drought, even in the special areas of the Pasni reks, the soil-moisture was too low for breeding.

It would be interesting to watch whether locusts would reappear again in case winter rains are received during the current winter season, and if so, to note wherefrom they would appear.

2. *Ambagh Field Research Station.*—Eco-climatic observations were made at Ambagh only from May after Mr. Taqi Ahsan took charge of the work. A statement of the observations made is attached (*vide* Statement F.). Rains commenced early and on the 26th June, the first fall was recorded. There was a total fall of 2·16" in June, 1·10" in July and 0·97" in August and a total of 4·23" for the year. Compared with last year's fall (13·40"), the year's record is low, and the breeding has been also relatively limited. Third instar hoppers are reported to have been collected on the 30th July, and the date of the earliest oviposition was probably about the end of June or the beginning of July, thereby showing that oviposition had occurred almost immediately after rainfall. During July, the average soil-moisture at 4" depth was 4·20 per cent., while in August it had decreased to 2·54 per cent., so that the conditions were not favourable for oviposition and development. The adults of the new generation began to appear in August. They did not show any decided pink colouration as was noted in October 1933. Mr. Taqi Ahsan reports that starlings appeared on the reks during July August, but was not able to make any positive observations in regard to their attacks on hoppers or adults.

Pasni Research Station had the honour of a visit by the Hon'ble Mr. B. T. Gould, I.C.S., Officiating Agent to the Governor-General in Baluchistan, accompanied by Mr. C. F. Squire, I.C.S., Political Agent in Kalat, Captain Saiyid Khurshid Alam Khan, Assistant Political Agent, Mekran, Khan Sahib Sherzaman Khan, Naib Wazir-i-Azam, Turbat and Sardar Bahadur Sardar Bhai Khan, on the 9th November, 1934.

8. November—II week . . . Yellow and pink coloured locusts found flying over village Suket in Kotah State in the second week of November.
Official Report.
9. November, 1933. . . . Light swarms reported by local people to have been found flying along the coast of Cutch from east to west, according to Mr. Bhatia.
Unofficial.
10. January 1st, 1934 . . . Locust swarms had appeared at village Seona, Tahsil Bhicangaon, District Ninat, Indore State on the night of 1st January, and disappeared.
Official.
11. February 26th, 1934 . . . A swarm of locusts appeared in village Jhotana, Katosan Taluka, Sabar Kantha Agency, Western India States on the 26th February, 1934 flying from east to west, without alighting on the ground.
Official Report.
12. July 20th, 1934 . . . A swarm of locusts reported to have appeared in the Puranpur Tahsil, Pilibhit district, United Provinces, in the evening on the 20th July entering the Tahsil from the east and passing on to the west without alighting on the ground.
Official Report.
13. 10th September 1934 . . . Locusts reported just north of the Hindu-Kush; a few swarms visited the Malakand Agency. (Probably *Docostaurus maroccanus*—the Moroccan Locust).
Official Report.

A study of locust movements in the areas of Rajputana, Central India and Western India States during years of locust activity shows that in the autumn and winter months the trend of locust flights is usually to the east and the south of Rajputana. Although actual specimens have not been secured in the case of any of the reports received in 1933-34, the direction of flights, wherever it has been mentioned, shows the same trend. Since it is known that, in consequence of the heavy rains received over the Indian Desert, a considerable breeding of the solitary phase type locusts had taken place in the deserts in Bikaner and Jaisalmer areas, it is not unlikely that small swarms had originated therefrom and had flown in various directions out of the Rajputana area.

In addition to the above reports, there were two newspaper reports of locust occurrence in the Karachi district one in January and the other in September. Both of them proved to be incorrect, the first one being found to be referable to flights of starlings, and the other, to common grasshoppers.

VI.—STUDY OF OLD RECORDS.

The following records were perused and information on locusts compiled therefrom :—

1. Locust Files from Mukhtarkars of Sinjhora, Sukkur, Garhi Yasin, Ghotki, Rato Dero, Khipro and Jacobabad.
2. Locust Files from Deputy Commissioner, Upper Sind Frontier.
3. Locust Files from Deputy Commissioner, Hissar.
4. Locust Files from the Imperial Entomologist, Pusa.
5. Locust Files of Jaipur State.
6. Locust Files of Ootch State.
7. Locust Files of the Naib Wazir-i-Azam, Turbat for 1908—1922.
8. Bombay Government Gazette—Cotton Reports, 1850—1871.
9. Bombay Government Gazette, Season and Crop Reports, 1872—1933.
10. Administration Reports of the Bikaner State, 1903—1930.
11. Administration Reports of the Rajputana Agency, 1890—1903.
12. Administration Reports of the Bahawalpore State, 1899—1930.

Compilation of information extracted in previous years from the following was attended to :—

1. Kalat State Records for 1911—22 and 1928—31.
2. Jodhpur Locust Registers, 1930-31.
3. Jaisalmer Records, 1894—1907.
4. Baluchistan Agency Diaries, 1900—1931.
5. Baluchistan Administration Reports, 1887 to 1931.
6. Cotes' Report on the Locust of North West India, 1869—1890.
7. Sind Official Gazette—Season Reports, 1872—1933.
8. Punjab File containing information for years 1869 to 1925 extracted by the (then) Locust Research Entomologist Lyallpur from the Punjab Season and Crop Reports and lent for perusal.
9. Khelat Diaries in the Foreign and Political Department Imperial Records Library, Delhi, 1878—1880.

In addition to the above, all the volumes of the Sind Official Gazette kindly lent for perusal by the Office of the Commissioner in Sind, Karachi, were gone through personally by me and the information available therein thoroughly studied, and all available data in regard to the rainfall in Sind for the years 1874 to 1933 extracted.

Locust Invasions in Sind during the period 1869—1933.—The information collected from the Season and Crop reports in the 'Sind Official Gazette' beginning from the year 1872 was examined in detail during the year and tabulated. Rainfall figures for the various years was also gathered as far as possible for purposes of correlation. The information given on locusts in the season reports is generally scanty, but in certain cases the directions of flights are indicated and sometimes data on breeding are also included. During the last locust outbreak, however, fairly detailed data have been obtained for Sind in

regard to the seasonal direction of locust movements, and these have been of service in the interpretation of the scanty data for past years. An analysis of the data gathered from the Season Reports would appear to show that, during years of locust invasions, Sind has been the scene of two series of locust movements almost every year:—one, in the pre-monsoon months of April, May and June, when the entry of fresh locust swarms from a western direction is recorded, first in the more western towns, such as Jolii, Mehar, Shikarpur or Jacobabad, and in later weeks in more easterly places and last of all in Thar-Parkar desert, and the other, from September onwards, when the incursion from an eastern direction of large swarms of pink locusts is indicated, which, after causing much damage to crops, gradually move on westwards towards Baluchistan. In years of good rainfall, oviposition would appear to occur in Sind, otherwise the swarms appear to move on during the rainy season into Rajputana for egg-laying and breeding.

During the past 65 years covered by the Sind Official Gazette data, locust invasions seem to have occurred in definite cycles, separated by distinct breaks. The first cycle extended from 1868 to 1881, during which period there were two or three short interruptions lasting about a year or two and clearly referable to deficient rainfall.

There was then a long break from 1882 to 1887. In 1888, a few locusts were recorded in Sind, and from 1889 onwards there was a long period of locust activity lasting up to the end of 1907. The break was a short one, extending from 1908 to 1911. The next cycle from 1912 to 1919 was, comparatively, not a vigorous one, and was followed by a period of locust quiescence of about 6 years—1920 to 1925. The recent 1926—1931 outbreak—which was spread over many countries of Asia and Africa, and the severity which is still within memory, has been succeeded by a period of locust inactivity, of the probable duration of which no statement can be made except that it has already lasted three years.

Attempts have been made to correlate the rainfall data with the fluctuations in the intensity of locust activity, and, in general, it would look as if the earliness and amplitude of winter and monsoon rains have a direct influence on the time of appearance and the magnitude of the spring and autumn swarms, respectively, in Sind. Breaks in infestation may be caused by the failure of winter or summer rainfall, and sometimes also by excess of rainfall. In most years, infestation starts by the entrance of swarms originating from the west, and Baluchistan is probably more important in starting outbreaks than Rajputana.

The Punjab data for the above period—1869 to 1925, which had been kindly lent by the Punjab Government Entomologist, have been cursorily perused, and it has been found that the locust cycles tally with those indicated by the Sind data. They require, however, to be studied in detail in correlation with the Sind data, after collecting information for certain years, which were lacking in the file received.

Data from the Bombay Government Gazette—1850 to 1933.—The data collected recently by Mr. Chandar Parkash from the Season and Crop reports in the old volumes of the Bombay Government Gazette have yielded much valuable information. Bombay Presidency proper is an area subject to the depredations of both the Desert Locust and the Bombay Locust (*Patanga succincta*), but while the flights of the Desert Locust, which are limited to Cutch and Kathiawar in years of ordinary invasions, reach the south of the Presidency only at times of extraordinary multiplication, the Bombay Locust has its home on the hill ranges of the Presidency. During years of activity, the

locust invades the whole of the Presidency proper, and extends its flights to the Central Provinces, the Hyderabad State and Madras Deccan. It is, therefore, in some cases difficult to make out which of the two species is referred to in the season reports. From the data collected the following statement may be made, in regard to the cycles of activity of the Bombay Locust :—

1873 to 1884 were years of activity of this locust, with a peak of development in 1883, and with two interruptions in 1876-77, and in 1880—both of them, times of drought in the Deccan.

This was followed by a long break from 1885 to 1896. The next cycle of activity was from 1897 to 1911 a long period with a few breaks in the middle. The peak of multiplication was reached in the years 1903, 1904, 1905 and 1907. From 1912, the locust seems to be in a state of quiescence, but references to damage by locusts in the south of the Presidency to be seen in the season reports of 1914, 1915, 1920, 1922, 1925 and 1926 may possibly be to this species, and definite information on this subject may possibly be obtainable from the Bombay Agricultural Department.

Since this Locust has proved a menace to agriculture in Peninsular India, it may be advisable to have its breeding areas properly investigated during its present phase of minimum activity.

VII.—CORRELATION OF METEOROLOGICAL DATA.

The following data were collected during the year from the records of the Government Meteorologist, Karachi, for the purpose of correlating them with locust movements :—

1. Rainfall data for stations in Mekran from 1911 to 1932.
2. Rainfall data for stations in Sind for 1875 to 1933.
3. Rainfall data for all important stations in Rajputana, Sind and Baluchistan for 1900 to 1932.
4. Rainfall data for all available stations in the desert area from 1850 to 1899.
5. Relative humidity data for stations in the desert area for the years 1926-1933.

VIII.—PUBLICATIONS.

I submitted the following two papers to the Third International Locust Conference : 1. "Summary of Locust Research Work carried on in North-West India under the auspices of the Imperial Council of Agricultural Research in India". 2. "The life-cycle of the Locust, particularly sexual maturation, in relation to climatic and other factors". Dr. Karandikar submitted a paper on "Studies on the Ecology of the Desert Locust in Southern Baluchistan" for publication during the year.

IX.—COLLECTIONS.

A good many of the collections of insects made during survey work were sent to the Imperial Institute of Entomology, London, and were received identified. Acridiids specially received attention and all the grasshoppers in the collection were classified and arranged according to their identifications. Some work was done by Dr. Karandikar in working out the biometrics of the locust specimens in the collections, and I took a large collection to the

Imperial Institute of Entomology, London, and attended to the measurements of about 500 specimens of locusts there according to the methods approved by the Locust Conference. During the year, a large number of plants sent for naming were returned identified by the Curator, Royal Botanical Garden, Calcutta.

X.—THE THIRD INTERNATIONAL LOCUST CONFERENCE.

Under instructions from the Imperial Council of Agricultural Research, I sailed from Bombay on the 18th August, 1934 and reached London on the 1st September for representing India at the Locust Conference. The Conference commenced on the 11th September and concluded its sittings on the 18th September. It was represented by 13 countries interested in Locust Research and was composed of over 50 delegates and advisers. From the 19th September I worked at the Imperial Institute of Entomology, London, engaged in making a biometrical study of a large collection of locust specimens—apparently all “solitary”—collected at different times and places in the course of survey tours in Baluchistan, Sind and Rajputana, and S. W. Punjab, during the years 1931-34. After visiting the laboratories at Rothamsted, Cambridge, Farnham Royal and Slough, and the Entomological museums and laboratories at Paris and Portici, I sailed back to India *via* Marseilles and arrived in India on the 7th November. I visited Poona on the 8th and the 9th for consulting Dr. C. W. Normand, Director of Meteorological Observatories in India and Dr. L. A. Ramdas, Agricultural Meteorologist in regard to the meteorological issues raised at the Conference and returned to Karachi on the 12th November.

The technical aspect of the various resolutions adopted at the recent Locust Conference is being reported on separately, but it may be useful to review some of the important issues briefly. One of the main outcomes of the Conference is a clarification of ideas in regard to terms variously and vaguely referred to in locust literature as “homes of the locust” and “permanent breeding grounds”. It has now been suggested that the areas in which locusts are found in a solitary or non-gregarious state should be regarded as its “areas of distribution” or in French as “aires d’habitat” and since it is only in certain restricted parts of this large area of distribution that the ecological conditions needed for the transformation of the solitary phase into the gregarious can come into existence, it has been decided that such centres should go by the name of “outbreak centres” or of the more expressive French term, “foyers gregarigènes”.

Territories subject to visitations are to be divided into (1) areas of *normal migration*, (2) areas of *occasional migration*, and (3) areas of *exceptional invasions*, and on this subject as also with reference to the fixation of “outbreak centres” in the Indo-Persian area, there is likely to be matter for much controversy in the present state of our knowledge.

Adverting to the subject of the formation of the initial swarms in the case of the Desert Locust, it is not clear whether it is a gradual increase of population in the course of successive good seasons, or a rapid succession of generations in a favourable year, that leads to it. It is a subject that needs a careful study.

In regard to migration, we have in India a number of fairly accurate records of locust movements made during the recent locust cycle, and a correlation of these with available data of the meteorological department may possibly lead us to some useful conclusions as to the various factors generally affecting locust migrations.

" With reference to the subject of the methods of field surveys employed in Locust survey work for noting the comparative density of the locust population and of the plant associations, it may be stated that on account of the sparseness of the population and the vast extent of the areas to be examined, only extensive surveys have been made. Intensive surveys are not likely to yield useful results if the population is thin, unless it be around the Field Stations. In regard to the plants found in the areas surveyed, all the commoner ones have now been collected and identified, but an accurate analysis of the plant associations in particular areas has yet to be made in detail.

The need for central laboratories for working out the details of the problems met with in Field stations has been rightly stressed, and there is little doubt that there is a great necessity of some of the fundamental problems being taken up and solved wherever facilities for investigation are existent.

" While the subject of controlling locust swarms in flight by aircraft is a fascinating one, the general indications are that in the present stage of development of the method, it is not likely to be of practical value in India.

" The standardisation of biometrical methods in the examination of locusts is of great value, since the ratios expressed by various workers—adopting different systems of measurements—have been rather confusing and misleading, as the biometrical values were not comparable.

ACKNOWLEDGMENTS.

" I take this opportunity of acknowledging my gratefulness to the various authorities in Sind, Bahichistan, Rajputana, Western India States, Punjab States and the Punjab for the ready help rendered to the Locust Survey staff during their tours in the areas under their jurisdiction and for the loan of Locust records for perusal. Similar help was received also from the Durbars of Kalat, Lasbela, Bikaner, Jaisalmer, Jodhpur, Bahawalpore, Khairpur, Cutch and Jaipur, and I acknowledge my thankfulness to them. The thanks of the Locust Research Department are due to Dr. S. K. Pramanik, Meteorologist, Karachi, and his staff for the unfailing help received from them on various occasions in regard to meteorological information, and for the loan of Thermometers, etc., for the screen at Chachro for recording meteorological data there. I wish also to express my indebtedness to Dr. C. W. Normand, Director of Meteorological Observatories, and Dr. L. A. Ramdas, Agricultural Meteorologist, Poona, for advice in regard to micro-climatic and meteorological observations in progress under me. I should personally express my gratefulness to Sir, Guy A. K. Marshall, Director, Imperial Institute of Entomology, London, and to Mr. B. P. Uvarov, Senior Entomologist, for facilities provided to me and help rendered in connection with biometrical work at the Institute, and for the identification of numerous insect specimens. My thanks are due to Mr. P. B. Richards, Government Entomologist, Cawnpore, for the loan of plans and for advice given in regard to the erection of a large cage at Pasni, to Mr. M. Afzal Husain for the loan of files on the Punjab Locust data for years prior to 1925, to the Imperial Entomologist, Pusa for a loan of his files on the Desert Locust, and to the Director of Records, Bombay, for the loan of the old volumes of the Bombay Gazette, and the Curator, Royal Botanic Garden, Calcutta, for identifying the plants sent.

" In conclusion, I wish to thank all the staff engaged on Locust Research work for carrying on work vigorously during the year in spite of the handicaps of a desert environment.

CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK.

Owing to the adverse rainfall conditions in winter and spring in the Baluchistan area during 1934 and to the somewhat deficient summer rainfall in Lasbela, there was a great diminution of the locust population in south Baluchistan in general. Even in Rajputana, where rainfall has approximated to normal this year, there does not seem to have been an increase of population, such as had been observed last year. In Rajputana, rainfall in the spring season seems to be of great importance not only in bringing about a numerical increase, but also in helping concentrations of locusts to form.

Since the ultimate aim of our scheme is the delimitation, within British limits, of all those areas actually capable of giving rise to migratory swarms, the present year's drought has given us a set-back, and our goal has apparently receded further back than last year. In fact, for want of locust material, even the very existence of the Pasni Field Station has been threatened and at the moment of writing, the prospects are very gloomy indeed, though a spurt of good rainfall during this winter may possibly bring about interesting developments.

The following general programme is submitted for adoption next year.

1. *Ecological Work*.—A continuation of the work at Pasni and Ambagh with the present staff, and with certain additions.

The present scheme of having a survey Assistant stationed at Karachi has not worked well this year and the Assistant Locust Research Entomologist, Pasni, suggests the appointment of a biologically qualified scientific Assistant—preferably with a training in meteorological work—to be stationed at Pasni for supervising survey work in Mekran, which is undoubtedly of great importance. At present there is a shortage of staff at Pasni and the appointment of one more Fieldman and a Peon for the Locust Research Assistant stationed at Pasni is suggested.

2. *Survey Work*.—From the results of the last two years, it is apparent that the greater part of the Indus Valley cannot be called a reservation area in the real sense, since locusts have been found only sporadically there. Most of the area is, moreover, an alluvial plain with only a few scattered sandy areas. In regard to the sandy areas near Dera Ghazikhan, where a breeding of the non-gregarious form of the locust has been noted during the last two years, they are apparently some sort of reservations, but as they are restricted in extent, they may not function as out-break centres.

Most of the locusts found during surveys have been obtained from areas within the great Indian Desert—which doubtless forms a huge reservation area for the locust. Since the whole area is sandy and full of vegetation during the rains, those portions that receive good and prolonged rainfall might function as out-break centres. Intensive survey work at Chachro has given some interesting results this year, but Sardarshahr has proved rather disappointing on account of the disappearance of locusts round about the place. But even at Chachro the population of locusts noted during the year has not been comparable to that of the Mekran Rek areas (*vide* Statement E). However, the work at Chachro and Sardarshahr might be continued for another season.

I would suggest that during the year 1935, the area to be kept under survey might be limited to the desert area and the desert fringes, thus eliminating a great part of Sind and Bahawalpore. The staff withdrawn from these

areas might be utilized for having one or two more centres like Chachro. Important areas in Sind, like Dadu and Larkana districts, might be visited once or twice a year at the time of breeding.

3. *Headquarters.*—The recommendations of the Locusts Conference lay special stress on the establishment of Central Laboratories and I should recommend that this might be seriously considered this year. In case it is approved, detailed proposals will be submitted.

The Compiling Staff.—Most of the compiling has now been finished, and the mapping of the movements can now be taken up after a chronological arrangement of the material collected. At the same time, all available meteorological data would also be obtained for the recent locust cycle for purposes of correlation. The addition of a Draftsman would greatly help mapping and enable copies of the maps being prepared for record and distribution.

Publication work.—It is necessary that some time should be devoted during the coming year to the writing up of the results of the survey work and of the results of the study of old locust records.

Detailed estimates will be submitted for the coming year separately.

STATEMENT A.I.

Details of Tours of Survey Parties.

I.—Khanpur Circle.

No.	Time of tour.	Personnel touring.	District.	Route followed.
1	6th to 16th January 1934.	Mr. Keshodas Bawoja and Fieldman Deokinandan.	Bahawalpore	Ahmadpur, East, Dunga-Bunga, Fort Abbas, and Khanpur.
2	9th January to 10th February 1934.	Bikaner Fieldman Narayan Behari.	Bikaner and Jodhpur State.	Bikaner, Nagaur, Merta, Jodhpur, Phalodi, Sujargarh and Sardarshahr, Nohar, Suratgarh, Lunkaransar and Bikaner.
3	17th February to 29th March 1934.	Assistant Mr. Bawoja and F. M. Bikaner.	Bikaner, Jaisalmer and Sukkur areas.	Suratgarh, Sri Bijonagar, Anupgarh, Rojri, Sattasar, Pugal, Jodasars, Barsilpur, Goru, Bikampur, Nachna, Tarana, Mohangarh, Jaisalmer, Chatral Khuiala, Asutala, Shahgarh, Lung, Tibba, Bharpurtha, Piarowaro Tar, Mamro and Rohri.
4	16th February to 22nd March 1934.	Khanpur Fieldman Deokinandan.	Bahawalpore	Rahim Yarkhan, Wah Faqiran, Ahmadpur East, Dorawar, Bahawalpore, Khairpore, Dunga Bunga, Fort Abbas.
5	16th to 20th April 1934.	Assistant Mr. Bawoja	Bahawalpore	Panjnad area, Mastoi, Allahabad.
6	8th April to 7th May 1934.	Bikaner Fieldman Narayan Behari.	Bikaner State	Bikaner, Sujargarh, Sardarshahr, Billun Nohar, Suratgarh, Mahajan, Lunkaransar, Badrasar, Bandralla and Surasar, Bikaner.
7	7th May to 3rd June 1934.	Mr. Bawoja, and F. M. Khanpur.	Bahawalpore	Rahim Yarkhan, Wah Faqiran, Ahmadpur East, Bahawalpore, Bahawalnagar, Fort Abbas, Fort Maret, Khanpur.

STATEMENT A-II:

Details of Tours of Survey Parties.

II.—Mirpurkhas Circle.

No.	Time of tour.	Personnel touring.	District.	Route followed.
1	1st to 10th January 1934.	Assistant Mr. Desraj Bhatia.	Western Sind .	Kotri, Chuharlak, Thano Bulakhan, Larkana, Akil, Rohri.
2	19th January to 15th February 1934.	Mirpurkhas Fieldman Didarsingh.	Jodhpur State	Barmer, Sarli; Sindhri, Padru, Dhanas, Bhinmal, Ramsar, Siana, Jalore, Bhadravan, Siwana, Balotra.
3	29th January to 20th February 1934.	Mr. D. R. Bhatia .	Kachhi and Sind.	Rohri, Bellput, Kunderi, Lehari, Bhag, Gandhawa, Nuttall.
4	25th February to 8th April 1934.	Mr. Bhatia and Mirpurkhas F. M.	Jodhpur-M a lani and Sind-Thar-Parkar District.	Barmer, Malpura, Nagarkhas, Dhori-mana, Chitalwana, Sanchor, Bhavatra Harrah, Virawah, Nagar-Parkar, Jhangro, Islamkot, Chachro, Chellar, Mithi, Diplo, Kurkasar, Suro, Rahimkibazaar, Kalohi, Naokot, Jhuddo, Mirpurkhas.
5	11th April to 12th May 1934.	Rohri, Fieldman Abdul Latif.	Western Sind .	Sehwan, Bubak, Shah Hassan, Tando, Rahimkhan Johi, Hairokhan, Tharri, Mehar, Mirzapur, Bago-dero, Shadadkot, Garhi Khairo, Dodapur, Larkana Akil, Rohri.
6	27th April to 7th June 1934.	Mr. D. R. Bhatia .	Cutch State and Thar-Parkar.	Mirpurkhas, Karachi, Mandvi, Bhuj, Sumrasar, Khavada, Mitti Well, Baliari, Diplo, Mithi, Chachro, Tar Ahmed, Khisar, Gadro.

II. Mirpurkhas Circle, contd.

No.	Time of tour.	Personnel touring.	District.	Route followed.
7	22nd May to 22nd June 1934.	Rohri Fieldman	East Sind including Khair-poro Stato.	Mirpur Mathelo, Khairpur Mirs, Sorah, Kotdiji Thari, Akra, Khewari, Rah-wari, Khadro, Sanghar, Sinjhora, Khipro, Mirpur-khas.
8	10th to 24th June 1934.	Chachro Fieldman	Tharparkar	Misrishah, Dhodwero Virawah, Borleo, Islamkot, Erniaia.
9	26th June to 24th July, 1934.	Rohri, Fieldman	Western Sind	Kotri, Thano Bulakhan, Kar-clat, Jhangar, Larkana, Kash-mor, Sui, Kandh-kot, Rohri.
10	25th June to 31st July 1934.	Mr. D. R. Bhatia and Mirpurkhas F. M. (Peshawari Singh).	Tharparkar	Mirpurkhas, Umar-kot, Mohondoro, Chachro, Charnor, Dadusar, Chohatan, Dhorimana, Har-palia, Bakasar, Gundi, Doori Sutianji, Hayat-jo-Tar, Dharandoro,, Dhakla and Chachro.
11	1st to 31st August 1934.	Mr. D. R. Bhatia	Tharparkar	Chachro, Misrishah Virawah, Jhangro, Islamkot, Kurka-sar, Suro, Singal, Saran, Diplo, Mithio, Chellar, Chachro, Khisar, Gadro,, Mirpurkhas.
12	3rd to 26th August 1934.	Rohri Fieldman	Western Sind	Rohri, Bubak, Shah Hassan, Tando Rahimkhan, Johi, Hairokhan, Tharri, Mado, Mirzapur, Ghaibidoro, Kam-bar, Rohri.
13	13th September to 15th October 1934.	Fieldman Mirpur-khas.	Tharparkar, Jai-salimoro and Jodhpur.	Mirpurkhas, Khipro, Hathoongo, Rana-hu, Mankahu, Mayajlar, Gura, Lakha, Sheo, Bhatka, Barmer, Sanawra, Dhoi-mana, Bhalikhal, Sindhri, Padru, Balotra, Hydera-bad.

II.—Mirpurkhas Circle—*concl'd.*

No.	Time of tour.	Personnel touring.	District.	Route followed.
14	8th to 24th October 1934.	Rohri Messenger .	Sukkur, Khairpur State.	Rohri, Kotdiji, Bozdar, Sanero, Akro, Khewari, Tujjal, Sorah, Kotdiji, Rohri.
15	27th September to 26th October, 1934.	Mr. D. R. Bhatia .	Tharparkar Cutch State.	Mirpurkhas, Umar-kot, Kantio, Chachro, Hayat-jo-Tar, Pilo-jo-Tar, Nagarparkar, Bela, Rapar, Bhachau, Anjar, Mundra, Mandvi, Karachi, Hyderabad.
16	1st to 13th November 1934.	Rohri Fieldman .	Sukkur .	Mirpur Mathelo, Yaru Land, Dharau, Piarowaro, Tar, Mamro, Rohri.
17	17th November to 3rd December 1934.	Rohri Fieldman .	Dadu District .	Dadu, Hairokhan, Tharri, Mado, Mirzapur, Ghaidero, Kambar.
18	29th October to 6th November 1934.	Chachro Fieldman .	Tharparkar .	Tar Charnor, Paboonjo Tar, Chapur, Bugal, Bhadee, Chachro.
19	18th November to 3rd December 1934.	Hyderabad Fieldman Peshawari Singh.	Tharparkar Jodhpur State.	Hayat-jo-Tar, Gundi, Tar Charnor, Khisar, Gadra, Barmer, Balera, Chohtan, Dedusar.
20	11th November to 5th December 1934.	....	Jodhpur Jaisalmero.	Barmer, Malpura, Gurha, Makna-kata, Chohtan, Bhachbhar, Sheo, Lakha, Deora, Phulia, Mayajlar, Lilma.

STATEMENT A-III.

Details of Tours of Survey Parties,

III.—Mekran Area.

No.	Time of touring.	Personnel touring.	District.	Routes followed.
1	25th December 1933 to 2nd January 1934.	Turbat Fieldman, Nasrullah.	Keoh Valley	Turbat, Nasirabad, Turmp, Mand, Bal, Kuhak, Kanisar, Turbat.
2	26th December 1933 to 7th January 1934.	Gwadar Fieldman, Muhd. Sharif.	Dasht Area Nigwar.	Gwadar, Kappar, Kanisar, Pittu, Shahzangi Kalat, Kuhak, Zarinbug, Suntsar, Gwadar.
3	11th February to 3rd March 1934.	Dr. Karandikar, Mr. Mirza Ahmed Ali Khan, Gwadar Fieldman (upto Kuntdar and the Turbat Fieldman afterwards).	Dasht Valley, Keoh Valley, Shadikaur Area.	Gwadar, Pishukan, Jiwani, Gabd, Puthan, Bishuli, Kuntdar, Turbat Pidarak, Ghulamani Bont, Pasni.
4	16th to 28th February, 1934.	Gwadar Fieldman	Dasht Nigwar	Gwadar, Pishukan, Jiwani, Gabd, Puthan, Bishuli, Kuntdar, Shahzangi Kalat, Kuhak, Ban, Kappar, Gwadar.
5	18th to 31st March 1934.	Turbat Fieldman	Keoh, Panjgur Buleda.	Sami, Hoshap, Tash, Guani, Sudan, Panjgur, Parom, Sarpar, m, Palan Goz, Buleda, Turbat.
6	17th to 21st March 1934.	Pasni Fieldman	Kulanch Area	Sardasht, Nokbur, Saur Kaur, Zintup, Chur Bundar, Pasni.
7	8th to 16th April 1934.	Ormara Fieldman	Ormara Area	Sanarichah, Kalmat, Gazdan, Razak, Kandilak, Ormara.
8	17th to 30th April, 1934.	Turbat Fieldman	Kolwah Area	Turbat, Sami, Hoshap, Rodkan, Chambarikalat Goshanak, Awaran.
9	2nd to 6th April 1934.	Gwadar Fieldman Abdul Hamid.	Pishukan Area	Gwadar, Pishukan, Jiwani and back.

III.—Mekran Area—*contd.*

No.	Time of touring.	Personnel touring.	District.	Routes followed.
10	25th April to 22nd May 1934.	Assistant Mirza Ahmed Ali Khan and Fieldman. (Turbat Fieldman joined him at Awaran; the tour was carried on motor lorry in the Mekran Area).	Lasbela, South Jhalawan Kolwah, Panjgur, and Kech Valley.	Karachi, Bela, Goko Pat, Mar Kaur, Nundara, Awaran, Hor Kalat, Hoshap, Saidan, Panjgur, Balgattar, Turbat, Nasirabad, Mand, Tump, Turbat, Pasm.
11	8th to 18th May 1934.	Gwadar Fieldman.	Dasht Nigwar.	Pishukan, Jiwani, Gabd, Puthan, Bishuli, Kuntadar Shabzargi, Kalat, Kuhak, Ban, Kappar, Gwadar.
12	4th to 8th June 1934.	Gwadar Fieldman.	Pishukan Area.	Gwadar, Pishukan, Jiwani and back.
13	5th to 14th July 1934.	Ormara Fieldman.	Ormara Area.	Rumro, Nakola, Basole, Ormara.
14	4th to 8th July 1934.	Gwadar Fieldman.	Pishukan Area.	Gwadar, Pishukan, Jiwani and back.
15	24th July to 14th August 1934.	Turbat Fieldman.	Kech, Kolwah, Panjgur, Buloda.	Turbat, Sami, Hoshap, Rodkan, Chambarkalat, Goshanak, Awaran, Kaur Dhat, Godri, Salori, Mitha Sing, Panjgur, Thana Daugh, Shakra, Kirki, Buloda, Turbat.
16	23rd August to 3rd September 1934.	Ormara Fieldman.	Ormara Area.	Nokbur, Ghulamani Bont, Rumra, Makola, Basolo, Ormara.
17	14th to 26th August 1934.	Gwadar Fieldman.	Dasht-Nigwar.	Gwadar, Pishukan, Jiwani, Gabd, Puthan, Bishuli, Kuntadar, Shanzangikalat, Kuhak, Ban, Kappar, Gwadar.
18	3rd to 12th September 1934.	Turbat Fieldman.	Kech Valley.	Turbat, Nasirabad, Mand, Tump, Kallag, Buloda, Turbat.
19	4th to 7th September, 1934.	Gwadar Fieldman.	Pishukan Area.	Pishukan, Jiwani, Ganz and back to Gwadar.

III.—Mekran Area—*concl'd.*

No.	Time of touring.	Personnel touring.	District.	Routes followed.
20	26th October to to 12th No- vember 1934.	Turbat Fieldman (Khushi Muihd.).	Keoh, Parom, Buleda.	Nasirabad, Tump, Mand, Aspikan, Wakai, Purchinan, Singisi, Parom. Dar, Dumugh, Buleda, Turbat.
21	10th to 14th October 1934.	Gwadar Fieldman .	Pishukan Area	Pishukan, Jiwapi and back to Gwa- dar.
22	13th to 21st October 1934.	Mr. A. C. Sen and Fieldman.	Nigwar-Kulanch	Pasni, Kandasole, Kappar, Gwadar.
23	3rd to 14th No- vember 1934.	Gwadar Fieldman .	Pishukan-Dasht- Nigwar.	Pishukan, Jiwani, Gabd, Pothan, Bishuli, Kuntlar, Shahzangakat, Kuhak, Ban, Kappar, Gwadar.

STATEMENT A-IV.

Details of Tours of Survey Staff.

IV.—Lashela Area.

No.	Time of touring.	Personnel touring.	District.	Routes followed.
1	5th to 18th March, 1934.	Sonmiani Fieldman	Hingol Area.	Bannodi, Badda Nakhotri, Khande- wari, Sangal, Hingol, Dhak Sapat, Pohr, Khidar Hayat, Damb, Ambagh.
2	16th to 27th April 1934.	Sonmiani F. M. (Khushi Muhd.).	Bela Area	Liari, Lhakhra, Khaddi, Bola, Thappi Thana, Wah Yara, Uthal, Shaikhraj, Ambagh
3	22nd May to 5th June 1934.	Ambagh Fieldman (Muhd. Shafi).	Hingol Area	Bannodi, Buddo Nakhetri, Khande- wari, Sapat, Sangal, Hingol, Chandragup, Pohr, Ambagh.
4	16th to 29th June 1934.	Fieldman Naurata Singh.	Hinidan Area	Miran Pir, Got Sherkhan, Shah Bilawal, Hinidan, Kila, Pabuni, Ambagh.
5	13th to 23rd July 1934.	Fieldman Khushi Muhammad.	Hingol Area	Nakhetri, Khande- wari, Sangal, Manjwari, Hingol, Chandargup, Sapat, Pohr, Ambagh.
6	19th to 29th August 1934.	Fieldman Khushi Muhammad.	Bela Area	Liari, Shah Lakhna, Khaddi, Sarish, Thappi Thana, Wah Yara, Uthal, Shaikhraj, Ambagh.
7	15th to 26th September 1934.	Fieldman Ambagh	Hingol Area	Gagu, Bannodi, Bud- da, Dambh. Nakhetri, Khande- wari, Sangal, Manjwari, Kund, Hingol, Chandra- gup, Sapat, Pohr, Sonmiani, Ambagh.
8	23rd to 29th October 1934.	Ambagh Fieldman	Hinidan Area	Got Shorkhan, Shah Bilawal, Hinidan, Kila, Naka Pabuni, Ambagh.
9	16th to 30th November 1934.	Ambagh Fieldman	Hingol Area	Bannodi, Tappo, Churani Kaur, Khandowari, San- gal, Manjwari, Kund, Sapat, Pohr, Baddo.

STATEMENT B-1.

Statement showing details of Locust Findings.

Months.	Mekran Rek Areas.						Lasbela Area.											
	Gwadar Rcks.		Pishukan-Jiwani Rcks.		Pasni Rcks.		Ormara Area.		Ambagh-Naka Kharati.		Hingol Area.		Bela Area.		Hindan Area.			
	L.	D. S.	Av.	L.	D. S.	Av.	L.	D. S.	Av.	L.	D. S.	Av.	L.	D. S.	Av.	L.	D. S.	Av.
January 1934 .	6	3	2'00	Not surveyed.		30	7	4'28	No surveys.		83	8	10'37	Not surveyed.		Not surveyed.		Not surveyed.
February .	18	3	6'00	10	3	3'33	63	7	0'28	No surveys made.		80	0	8'89	Not surveyed.		Not surveyed.	
March .	93	8	12'25	No survey.		32	7	7'42	Not surveyed.		72	8	9'00	98		8		12'25
April .	38	4	0'50	48	3	9'00	75	0	12'50	10	7	1'23	Not surveyed.		2 (found near Lahr)		6 0'33	
May .	13	1	13'00	39	3	13'00	40	0	5'11	Not surveyed.		10	3	3'33	72		9	
June .	74	7	10'57	53	5	11'00	38	0	4'22	Not surveyed.		9	7	1'29	Not surveyed.		Not surveyed.	
July .	13	6	7'16	33	5	7'00	7	0	0'77	No locust.		14 (including 4 hop pers).	22		3		1'75	
August .	4	3	1'33	0	3	2'00	2	3	0'10	No locust.		14 (including 9 hoppers)	Not surveyed.		Nil		7	
September .	2	2	1'00	2	4	0'50	3	10	0'30	23rd August to 3rd September		30	2'14		33		10	
October .	1	3	0'33	1	5	0'20	No locust.		5	0'00		99	14		7'07		3'30	
November .	No locust.		2	0'00		3	0'00		0	0'00		42	11		3'81		Not surveyed.	
												23	11		2'27		22	
												8	2'75		Not surveyed.		Not surveyed.	

L. = No. of locusts observed during the month.

D. S. = No. of Day surveys during the month.

Av. = Average No. of locusts observed during a day's survey.

STATEMENT B-2.

Details of Locust Findings.

Mekran Hinterland.

Period.	Kulnuch.	Locust	Dasht-Nigwar.	Locust	Keechi Valley.	Locust	Kolwah Valley.	Locust	Panigur.	Locust	Kachhi.	Locust
Winter.	I—xiv—33.		Tour III—(2) 26xi 33—7—7—31		Tour III (1) 25-xii 33 to 2—1—34.						Tour II (3) 17—1—	
December to February.	XII Khandasole-Kapper. 13—xii—1—xi. Chakuli Kandazole	4 3	XII 20-xii Kapper 27-xii Ban 29-xii Kunkar 31-xii Mand. 1—31 Pktu. Tour III (1) 16-ii 28-ii	1 1 1 3 0	XII 25-xii Turbat 27-xii Turbat 29-xii Turbat I. 24-34. Kunkar Turbat.	2 5 1 2	Not surveyed		Not surveyed		II. Bellput, Kinneri, Lehri Bhag, Gandawa.	Nil.
Spring.	Tour III—(6)—17-21 tu—34.		II. 20-ii. Kuhak to Ban. Tour III (1) 11—11. 17—34.	1	Tour III (5) 13 31—ii—34.		Tour III (8) 18— 24-iv.		Tour III (5) 13— 31 tu.			
March to May.	III. Sardasht-Nokbur.	Nil.	V. 12-v. Puthon-Beshuli. 16-v. Kurbak-Ban. 17-v. Ban-Kapper.	0 3	III. 18-iii Sami . Tour III—(7). IV. 17-iv. Sami . Tour III (10) 30-iv 18—v—ii.	2 Nil.	IV. Hoshap, etc. 24-iv. Awarnn . Tour III (10) 17-v V. Kolwah Area.	Nil.	III 21-iii. Tash 24-iii. Panigur 20-27-iii. Parom Saracen. 31-iii. Bulefirt Turbat. Tour III (10) 3-6-v.	2 1 3 2		
Summer.			Tour III (17) 16- 27-vii.		Tour III (15) 25 24—vii—11-viii		Tour III (16) 25 31-vii.		V. Saldan-Panigur	Nil		
June to August.		VIII.	24-viii. Kuhak to to Ban.	1	VII. 1-15-viii. Turbat . 24-viii. Sami .	2 2 Nil.	VII. 20-27-viii. Rolkna . 30-viii. Geshran- ak-Awaran 31-viii. Awaran	2 2 2	VIII. 5-viii. Saleri 6-viii. Mithas- ingha 10-7. Thana 11-viii. Shakraik 14-viii. Buleda— Turbat.	1 2 3 2 2		

11 mth.	Tour III (22) 13-17-x.	Tour III (23) 5-13-xi.	Tour III (18) 3-10-12.	Tour III (20) 26-x-12-xi.	Tour III (20) 31-x-12-xi.	
September to November	X. Kandahole Nil	XI. Gab to Kappar. Nil	IX. 6-xi. Mand. Tour III (20) 26-x-12-xi. X. 28-x. Nactra-bud-Tump 29-x. Tump 30-x. Tump to Mand.	2 1 2 2	XI. 1-xi. Wakel 8-xi. Parom. 11-xi. Rudega. 3 4 2	

STATEMENT B-3.

Details of Locust Finding.

Northern Desert areas of North-West India.

Period.	South- West Punjab.		Ra'putana.		North Jodhpur.	Jaipur.
	Dera Ghazi Khan District.	Bahawalpur Area.	North Jaisalmer.	Bikaner.		
Winter Season. December 1933 to February 1934.	Not surveyed.	Tour (1) 6-16-i. I. Fort Alib in Area	Nil	Tour I (2) 9-31-i. I. Bikaner-10-11-i	November 1933 Philodi. Tour I (2) 9-31-i.	
		Tour II (1) 16-i to 17-iii.	Not surveyed.	Tour I (3) 17-i-i to 25-iii		
		II. 14-ii. Rehar Yar Khan. 20-ii. Wadi Eadharan. 26-ii. Ahmedpur East.		II. 12-ii. Bikaner . 19-ii. Surwarth . 21-23-ii. Sri Bihavpur. 23-24-ii. Annapurath. 26-ii. Rojri . 24-ii. Patali.	I. Nagar, Patalodi, etc. Nil. 1 5 2 2 3 1 1	
			Tour I (3) 19-ii to 27-iii.	Tour I (4) 1-16-7e.		
Spring Season. March to May.	Not Surveyed.	III. 17-18-ii. Fort Alibay. Tour I-(4) 16-26-iv IV. 17-iv. Mastel	III. 7-iii. Bikanpur . 8-9-iii. Nachina Other places . Nil.	IV. 1-iv. Bikaner . 9-iv Sri Kotoyaji 11-iv. Sniugath V. 2. v. Indrasar 6-v. Surasar .	3 1 1 8 1	
		Tour I (7) 7-v to 3-vi.	Tour I (6) I. IV-7V	Tour I (8) 17-v to 9-vi.		
		V. 10-v. Fadran. 10-v. Ahmedpur East.		V. 19-v. Bikaner 10-v. Xapasat, etc. 22-v. Surwarth. 30-31-v. Rojri .	1 5 1 0	

Summer Season.	Tour I(10) 13-27-vi	Tour I(13) 27-viii to 11-viii.	Tour I(11) 13-30-vi.	Tour No. I(11) 17-30-viii.	
June to August.	VI 21-vi. Dera Ghazi Khan	VII-VIII— Sura Dabhar Islamgarh Tour I(14) 4-7-viii. VIII. Shulka Wahan.	VI— 19-21-vi. Nokh 22-24-vi. Baru Khara. Tour I(13) 27-viii to 11-viii. VIII. 0-7-viii. Bhutan Wala Tour I(15) 4-21-viii. VIII— 4-5-viii. Nokh 11-viii. Nachana 14-viii. Bukam- pur.	VI— 2-4-vi. P. r. r. l. 6-7-vi. Badkisar. 9-12-vi. Bikaner. Tour I(11) 15-vi- 29-vi. VII. 5-10-vii. Sardarsahr Tour I(16) 13-30- viii. VIII : 21-viii. Sardar. shahr (new brood) 26-viii. Pural 29-viii. Rojri (new brood).	2 1 4 3 1 1 20 1 1 1 1 1
Autumn Season.	Tour I(21)-27-x to 3-xi.	IX— Roda, Toha Rell-iv. Fort Narer	IX— 0-1 x. Bikaner (new brood). 9-1x. Sardarsahr Tour I(21) 20-x-17-xi. X-20-x. Hardesar XI-2-xi. Pipasar Tour I(22) 11-29-xi. 21-xi. Sardarsahr	IX : Jalpur State.	Tour I(18)-16 16-x to 29-xi. IX : Jalpur State.
September to November.	X. 29-31-x. Dera Ghazi Khan. adults : 26H. XI—1-xi. Taunsa adult. 2-xi. 11th Kasrani Adults : 97 Hoppers : 8	Tour I(18) 1-7-x. X. Chachran. etc.	X.	Jalpur Jalpur	

STATEMENT B-4.

Details of Locust Findings.

Southern Desert Areas.

Period.	Western Sind.	Sind.	Thar Parkar.	South Marwar Malahani.	Rajputana South Jaismere.	W I States Cutch.	Loc.
<i>Winter Season.</i>							
December to February.	Tour II (1)-1-10-1. I Larkhan	Tour I (1)-17-ii to 23-iii. III. Sukkur Desert area (Pharewaro Jar-Kohir).			Tour II (2) 19-i-13-ii.		
	1	Nil.		1. 20-i. Barmer . 24-i. Sindhri . 20-i. Padra . 28-i. Dhanas . 31-i. Bhimmal . II. 2-ii. Ramgar . 3-ii. Sini . 7-ii. Bhadravan .	2 1 1 1 1 1 3 1		
<i>Spring Season.</i>							
March to May.	Tour II (1) : 11-iv to 12-v. IV. 12-iv. Seliwan (Yellow) 13-iv. Tando-Rahimkhan (Pink) 20-iv. Hairo Khan 22-iv. Tharri . 30-iv. Mirzapur	Tour II (7) : 22-v to 23-vi. V-VI. Khairpur Area Nawabshah district.	Tour II (4) : 9-ii to 3-iv. III-IV. Nogar Parkar, Chachro, Driplo, Mithi Talhar. Tour II (6) : 12-v to 20-v. 19-v. Chachro outpost.	Tour II (1) 27-ii-9-iii. II-III. Malani Area		Tour II (6) 30 iv-10-v-33. V. 1-v. Mandvi, Bhui, Khavda etc.	3 Nil.
<i>Summer Season.</i>							
June to August.	Tour II (2) 1-24-vii. VII. Dadu, Larkhana and U. S. I. Districts. Tour II (12)-3-26-viii.		Tour II (10) 26-vi to 31-vii. VI. 29-vi. Mohendero. 1-30-vi. Chachro outpost. VII. 12-vii. Chachro.	Tour II (10) : 26-ii to 31-iii. VII. Malani Area			Nil. 5 2

STATEMENT D.

Monthly Rainfall Date for 1933.

Months.	Panjgur.	Gwadar.	Pasni.	Ormara.	Bele.	Ambagh.	Karachi.	Chachro.	Sardar-shahr.
January	0.32	2.37	0.24	0.39	0.01	..	..	..	..
February	1.68	5.88	6.09	3.50	0.56	0.46	0.01	..	0.75
March	1.37	6.70	0.17	0.03	..	..	..	0.20	..
April	1.49	3.30	5.37	3.02	0.65	0.50	0.14	0.60	..
May	0.14	..	..	..	1.34	..	0.91	0.70	0.44
June	0.30	..	..	..	..	..	..	0.63	1.62
July	1.62	..	0.67	0.91	4.58	9.50	15.50	4.78	0.68
August	0.02	..	0.02	0.50	2.60	2.20	3.44	3.11	6.80
September	..	..	..	0.06	3.56	1.70	2.67	1.20	2.32
October	..	..	..	..	..	..	..	..	..
November	0.03	0.46	..	..	..	..	..	..	..
December	..	..	0.03	..	..	..	..	..	..
Total	7.26	12.71	12.59	8.41	13.30	14.36	22.67	11.24	12.61

STATEMENT E.

Comparative Statement of Locust Population noted during the year 1934 at Stations under intensive Survey work.

Months.	Gwadar.			Pasni.			Ambagh.			Chachro.			Sardarshahr.			Remarks.
	L.	D.S.	Av.	L.	D.S.	Av.	L.	D.S.	Av.	L.	D.S.	Av.	L.	D.S.	Av.	
January 1934	6	3	2.00	30	7	4.28	83	8	10.37							L.—Number of Locusts observed during the month. D. S.—Number of Day-survey. Av.—Average number of locusts observable during a day's survey.
February	18	3	6.00	65	7	9.28	80	9	8.88							
March	98	8	12.25	32	7	7.42	72	8	9.00							
April	38	4	9.50	75	6	12.50	6	6	1.00							
May	13	1	13.00	46	9	5.11	10	3	3.33	Work begun in May 1934.			Work begun in July 1934.			Av.—Average number of locusts observable during a day's survey.
June	71	7	10.57	38	9	4.22	9	7	1.28	1	15	0.07	3	15	0.20	
July	43	6	7.16	7	9	0.77	14	11	1.27	1	15	0.73	3	15	0.20	
							(Hop-pers present.)			(Hop-pers present.)						
August	4	3	1.33	2	5	0.40	30	14	2.14	136	23	5.91	1	15	0.07	
							(Hop-pers present.)			(Hop-pers present.)						

September	.	2	2	1.00	3	10	0.30	99	14	7.07	58	28	2.07	1	15	0.07
October	.	1	3	0.33	0	5	0.00	42	11	3.81	37	13	2.81	0	15	0.00
November	.	0	2	0.00	0	6	0.00	25	11	3.81	10	15	0.66	1	15	0.07

(A few hopper.)

STATEMENT F.

Monthly averages of the Daily Maxima and Minima of Meteorological Observations on the Ambagh Rek from May to November 1934.

	April.	May.	June.	July.	August.	September.	October.	November.
Screen. Temperature	81.2±16.4	81.3±10.7	85.8±7.3	86.35±4.65	85.7±4.2	83.3±6.9	78.8±11.7	73.0±16.8
Rel. Humidity.	60% ± 23	73% 20	76% ± 14	73% 7	80.5 % 11	81.5% 11.5	61.3% 22	65% 20
Open Air Temperature.		29.7 ± 1.8	30.5 ± 3.0	30.85±2.75	29.8±3.1	28.5±3.8	27.4±7.1	23.5±8.8
Sandy Soil Temperature (Open)		35.9±11.5	30.1±8.5	34.5±0.4	34.0±7.3	35.6±10.2	32.5±13.0	27.2±13.3
Vertical.		38.9±15.1	38.7±11.2	37±8.0	37.8±10.4	37.7±12.4	34.3±15.8	29±15.6
Horizontal.		36.3±6.0	37.7±6.8	34.55±4.45	35.4±2.1	31.3±5.1	31.2±6.3	26.5±7.1
2" Deep.		35.5±4.3	30.7±1.4	33.7±3	33.3±2.1	33.7±3.3	30.8±3.0	26.1±4.6
4" Deep.		35±2.8	35.0±2.0	33.1±1.0	33.2±1.3	33.2±2.2	30.6±2.5	25.8±2.9
6" Deep.								
Sandy Soil moisture.		.92%	1.95%	1.8%	.65%	.83%	.96%	.8%
Surface.		.85%	1.97%			1.34%	1.24%	.73%
2" Deep.		.60%	1.97%	1.2%	2.54%	1.71%	1.69%	.71%
4" Deep.		.75%	1.9%			1.82%	1.62%	.74%
6" Deep.								

Evapora- tion.	In Sun. In Shade.	11.4 c.c. 7.3 c.c.	9.7 c.c. 4.4 c.c.	10.6 c.c. 4.2 c.c.	9.1 c.c. 3.8 c.c.	9.4 c.c. 4.3 c.c.	10.4 c.c. 5.6 c.c.	9.8 c.c. 3.9 c.c.
Wind.	Total Mile- age in 24 hours. Maximum velocity (per hour).	128.5 mls. 11.5	144.2 10.4	173.4 11.6	140.2 10.5	118.92 10.08	51.5 6.8	27.5 3.2
	Barometric variation.	Nil.	From 29.48 to 29.85	From 29.5 to 29.8	From 29.63 to 29.99	From 29.8 to 30.09	From 29.91 to 30.25	From 29.88 to 30.18
	Rain.	No rain.	2.16"	1.1"	0.97"	No rain.	No. rain.	Total rain = 4.23"

STATEMENT G.

Statement showing the Hoppers found during 1934 in Thar-Parkar Deserts Areas.

District.	Locality.	Date.	Number of hoppers found.						Remarks.
			I stage	II	III	IV	V	Total.	
Thar-Parkar.	Hayat-jotur	29-7-34	1	2	2	5	First breeding.
	Dharan Dero	30-7-34	8	1	..	..	..	9
	Dhakla	31-7-34	..	1	..	..	..	1
	Kantio	6-8-34	3	3	2	..	..	8
	Misreeslah	8-8-34	2	..	..	..	..	2
	Virawah	11-8-34	..	..	..	..	1	1
	Chachro	1-8-34	2	..	..	..	..	2
		6-8-34	3	..	1	..	..	..
		7-8-34	..	..	..	1	2	3
		8-8-34	5	5	1	..	..	11
		10-8-34	2	2	..	1	2	7	
		11-8-34	5	..	7	..	..	12
		12-8-34	1	1	Second (?) breeding.
		13-8-34	..	..	..	1	..	1
		14-8-34	..	..	..	1	1	2
		20-9-34	..	..	..	1	..	1
		5-10-34	..	..	..	1	..	1
		15-10-34	..	..	..	..	1	1
Total at Chachro			17	7	9	6	7	46	
Total at places other than Chachro.			14	7	4	..	1	26	
GRAND TOTAL			31	14	13	6	8	72	

D. R. BHATIA,
Locust Research Assistant,
Mirpurkhas Circle.

Statement showing the Staff employed under the Locust Research Entomologist to the Imperial Council of Agricultural Research, Karachi, during 1934-35.

Name and designation.	Date of appointment.	Present pay (On 1st Dec. 1934).	Remarks.
1. Rao Sahib Y. Ramchandra Rao, M.A., F.R.E.S., Locust Research Entomologist, Karachi.	13th Dec. 1930.	Rs. 1,000 plus Karachi Local Allowance Rs. 60 per mensem.	On Foreign Service.
2. Mirza Ahmed Ali Khan, Locust Research Assistant.	11th Jan. 1931.	Rs. 160 plus Rs. 15 Karachi Local Allowance.	Do.
3. Mr. Abdul Ghani, Head Clerk.	13th Jan. 1931.	Rs. 130 plus Karachi Local Allowance Rs. 12-8-0 per mensem.	Do.
4. Mr. Mohammed Ramzan, Second Clerk.	1st May 1932.	Rs. 52 plus Karachi Local Allowance Rs. 7-8-0 per mensem.	
5. Mr. H. G. Shaikh, Third Clerk.	2nd Oct. 1933.	Rs. 37 plus Karachi Local Allowance Rs. 7-8-0 per mensem.	
6. Mr. Chandar Parkash, Compiling Assistant.	27th April 1933.	Rs. 67 plus Karachi Local Allowance Rs. 10 per mensem.	
7. Mr. Shanti Lal, Compiling Assistant.	1st June 1933.	Rs. 67 plus Karachi Local Allowance Rs. 10 per mensem.	
<i>Fieldmen.</i>			
1 Fieldman on Rs. 30	..	Rs. 30 plus Rs. 6 House Rent and Karachi Local Allowance.	
1 Fieldman on Rs. 41 including Rs. 10 Motor Lorry Allowance.	..	Rs. 41 plus Rs. 6 House Rent and Karachi Local Allowance.	
<i>Peons.</i>			
1 Peon on Rs. 18 plus Rs. 6 House Rent etc., per mensem.	..	Rs. 18 plus Rs. 6 House Rent and Karachi Local Allowance.	Local.
2 Peons on Rs. 17 plus Rs. 6 House Rent etc. each per mensem. (Including one peon for Mekran Survey Work.)	..	Rs. 17 plus Rs. 6 House Rent and Karachi Allowance.	
<i>B.—Survey Party.</i>			
1. Mr. Keshodas Baweja, M.Sc., Locust Research Assistant, Khanpur.	12th Dec. 1930.	Rs. 350 per mensem	On Foreign Service.
2. Mr. Desraj Bhatia, M.Sc., Locust Research Assistant, Hyderabad (Sind).	2nd Jan. 1931.	Rs. 160 per mensem.	

Name and designation.	Date of appointment.	Present pay (On 1st Dec. 1931).	Remarks.
<i>Fieldmen.</i>			
2 Fieldmen on Rs. 31 per mensem.	..	Rs. 31 per mensem.	
4 Fieldmen on Rs. 30 each per mensem.	..	Rs. 30 per mensem.	
1 Fieldman on Rs. 30 plus Rs. 4 House Rent etc. per mensem.	..	Rs. 30 plus Rs. 4 House Rent and Local Allowance per mensem.	
1 Messenger on Rs. 12 plus Rs. 4 per mensem.	..	Rs. 12 plus Rs. 4 House Rent and Local Allowance per mensem.	
7 Messengers on Rs. 12 per mensem each.	
1 Peon on Rs. 15 per mensem.	
1 Peon on Rs. 15 plus Rs. 4 House Rent etc., per mensem.	..	Rs. 15 plus Rs. 4 House Rent and Local Allowance per mensem.	
<i>C.—Pasni.</i>			
1. Dr. K. R. Karundikar, Ph. D., Assistant Locust Research Entomologist, Pasni.	18th Oct. 1931.	Rs. 370 per mensem.	
2. Mr. Atul Chandra Sen, M.Sc., Locust Research Assistant.	10th Jan. 1931.	Rs. 160 plus Rs. 75 Local Allowance.	
3. Mr. Abdul Halim, Clerk.	10th June 1932.	Rs. 52 per mensem.	
<i>Fieldmen.</i>			
4 Fieldmen on Rs. 41 each (at Pasni, Turbat, Ormara and Gwadar).	
2 Fieldmen on Rs. 21 each at Pasni.	
1 Peon on Rs. 18 at Pasni.	
3 Messengers on Rs. 10 per mensem each (at Ormara, Turbat and Gwadar).	
1 Water Carrier on Rs. 10 at Pasni.	
<i>Ambagh Laboratory.</i>			
1. Syed Mohammed Taqi Ahsan, M.Sc., Locust Research Assistant.	28th March 1931.	Rs. 125 per mensem.	
2 Fieldmen on Rs. 40 each.	
1 Fieldman on Rs. 30 per mensem.	
1 Messenger on Rs. 10 per mensem.	
1 Peon on Rs. 18 per mensem.	

21-24. If these general lines are accepted, a review of existing markets will have to be carried out to ascertain approximately how much gram is handled at each and what facilities are needed there. The number of wholesale *mandis* in India is less than 2000 but "*kats*" number more than 22,000. This work should proceed along with the development of marketing and the latter should not be held up till the former is completed.

21-25. *Recommendations.* (1) Standards and grades should be laid down by legislation for non-perishable commodities which are marketed in large quantities and especially for those which are exported.

(2) Regulated markets should be established in the 2000 odd existing *mandis* and necessary legislation should be passed for the purpose. Standard weights and measures should be introduced as without the introduction of these it will be difficult to regulate markets.

(3) There should be an inspector for each regulated market, and a separate news service marketing staff both for internal trade and for import and export trade.

(4) The necessary storage accommodation should be constructed of a type which will prevent waste and rat infestation and where fumigation can be easily carried out.

(5) Fair prices should be fixed for the more important food grains.

(6) Village organisations, linked up with the development of the co-operative movement, should be established for seeing to the cleaning, bulking and sale of village produce.

(7) Traders at all stages should be licensed.

(8) Buffer stocks should be maintained by Government.

(9) Government collecting and marketing depots should be established experimentally for perishable commodities, such as vegetables.

(10) Proper methods of preservation of vegetables, e.g., cold storage, dehydration, etc., should be developed where feasible.

21-26. *Cost.* The cost of constructing modern grain stores for 20 million tons of grain would be of the order of Rs. 100 crores. The recurring cost of the marketing and inspecting staff (inspectors for each of 2000 regulated markets and a corresponding number of news service staff) would be about Rs. one crore a year.

CHAPTER III.—FRUIT AND FRUIT PRODUCTS

22-1. The chief fruits produced in India are mangoes, bananas and citrus. Their total production has been estimated in the marketing surveys at ten million tons a year; this is equivalent to six million tons when allowance is made for stones, skin, etc. This works out at two ounces per day on the population basis for each adult unit, and is the minimum that nutrition experts consider necessary for health. Actually, however, nutrition surveys have shown that in most parts of India, people do not get anything like this quantity of fruit to eat. It appears, therefore, that the estimates of production are too high and that steps are necessary to increase fruit production.

22-2. There seems to be considerable scope for increasing the production from the existing acreage. In most areas, orchards (and particularly mango groves) are neglected or derelict. Little attention is paid to the proper treatment and care of the trees.

22-3. The first step in any plan of development is to review the production and the requirements of each tract, to determine what increases and of what kind are needed and to indicate what action is required in respect of the different orchards. In some areas it may be feasible to renovate the existing trees. In others it may be necessary to cut them down and plant new trees. Where feasible new orchards may be planted on fresh land, and when they have begun to bear fruit, the existing orchards can be cut down and the land turned over to agriculture.

22-4. The plan of work for an orchard would include its future proper maintenance. The correct treatment in respect of cultural and manurial-

operations would be given. The sprays to be used for protection against pests and diseases would be indicated. The economics of such operations would, of course, have to be borne in mind, and investigated where necessary. Preliminary research may be needed, especially in the case of mangos, before sound technical advice can be given.

22-5. Where new orchards have to be planted, the working plan would give details of the best layout, the most suitable variety to plant, the root-stock on which to bud or graft, the pruning and other treatments to be given in the initial stages, and so on. The soil may have to be analysed to suggest the most promising manurial treatment. The aim would be to replace the present low-yielding, inferior quality trees by new ones producing a larger quantity of superior quality.

22-6. It has been calculated that it might be necessary to supply no less than 1,000,000 seedlings a year in British India for five years. It would probably be necessary to arrange for their production at registered nurseries managed or, at least, controlled by Government. Special precautions should be taken to issue from nurseries only plants which are free of disease.

22-7. Necessary propaganda and demonstration would have to be carried out by the proposed staff to ensure the acceptance of the plan of work which has been drawn up and to see that it is carried out.

22-8. Spraying machines and insecticides should be made available to fruit-growers at cheap rates in adequate numbers. The feasibility of making spraying or other pest control measures compulsory in certain areas will have to be looked into.

22-9. To secure the full co-operation of orchard owners, it will be necessary to have a Fruit Development Board in each province, with branches in the more important districts. This may have to be supplemented by the formation of bud societies, which will register trees which have good fruits in large quantities and arrange for the mass production of necessary nursery plants from such trees and for budding *in situ*.

22-10. If fruit production is to be properly developed, there should be a Central Fruit Adviser who can give advice as to the lines on which research and development work are needed and should be carried out. He should also conduct some research himself, if feasible.

22-11. The same officer can also advise on the marketing of the fruit. The present system in most places is that the owner leases out his orchard and the lessee does the collection, transport and sale to the consuming market. Opinions may differ as to the value of the services the lessees render as compared with the prices they pay and what they receive. But it has to be borne in mind that they do suffer heavy losses in transit.

22-12. Refrigerated transport and cold storage facilities are needed on a big scale, if these losses are to be prevented. How far they will be economically profitable if done on a large scale needs to be worked out by actual trials.

22-13. One of the main difficulties in connection with fruits is that the production is largely seasonal. At certain times of the year there is a glut of fruit and a certain amount of spoilage. In other seasons there is practically no fruit. Hence, methods have to be found for preserving fruit in times of excess to make it available in times of scarcity. To some extent this purpose can be served by cold stores and by quick freezing. But other devices have also to be adopted, such as drying, canning and the making of various preparations like candies, jams, syrups and squashes.

22-14. There is such a big field for fruit preservation in India that it is necessary to set up a Central Institute for dealing with the subject, carrying on the necessary research, imparting training to staff who have to carry out this work, giving technical advice and guidance to industrialists and testing the quality of the production. This Institute has to be supplemented by regional fruit preservation centres for dealing with local fruits.

22-15. Care will have to be taken to ensure that the fruit products prepared in India are manufactured under hygienic conditions and marketed with a
 ct: otherwise, the whole industry may suffer, because of

defects found in the articles sold by one or two unreliable firms. The question of legislation to ensure cleanliness has to be considered at an early date.

22-16. At the same time steps have to be taken to ensure that Indian-made fruit products are able to stand competition with imported products. The question of subsidies may have to be looked into in this connection. Further, arrangements should be made for manufacturers to obtain the sugar they require at reduced rates or free of excise duty, as also the necessary containers, bottles, tins, etc., at cheap rates. It is necessary for this purpose to arrange for the manufacture of containers in India.

22-17. *Recommendations.* (1) Existing fruit orchards should be renovated where sensible or cut down if they are uneconomic and new ones planted instead.

(2) Arrangements should be made for the production and supply of the necessary nursery plants of known origin.

(3) A plan of work should be drawn up for each orchard and be accepted by the owner.

(4) Spraying machines and insecticides should be made available at cheap rates, they should be manufactured in India, if feasible.

(5) In certain cases pest and disease control should be made obligatory.

(6) A Fruit Development Board should be set up in each province.

(7) Bud selection societies should be established, where feasible.

(8) A Central Fruit Adviser should be appointed: he would help in both production and marketing.

(9) Refrigerated transport and cold storage facilities should be provided.

(10) Fruit preservation by quick freezing, canning, drying, etc., should be developed.

(11) A Fruit Technological Institute should be established, along with a number of regional stations.

(12) Legislation should be introduced to ensure that fruit products are manufactured under hygienic conditions.

(13) Indian fruit products should be placed in a position to withstand competition from abroad.

(14) Facilities should be made available to Indian fruit products manufacturers for obtaining sugar and containers at cheap rates.

22-18. *Cost.* So little is known at present about fruit production that it is not feasible to estimate the likely cost of renovating orchards. The expenditure involved in reviewing the position would be only a few thousand rupees. Research and experimental orchards would form part of the general plan of agricultural research and experiment. The cost of refrigerated transport and cold stores required also cannot be estimated at the present stage. But if even 1/10th of the production, i.e., 600,000 tons has to be kept in cold stores, the capital cost of 300 stores of 2000 tons capacity each would be 3 crores of rupees. Finally, the cost of the Central Fruit Adviser and a Fruit Products Institute would be of the order of Rs. 75,000 a year to begin with.

CHAPTER IV—ANIMAL PRODUCTS

Technical Problems

23-1. India has 200 million bovines, of which one-third are male, one-third female and one-third young stock. The males are mostly bullocks used for ploughing or transport. The number of bulls suitable for breeding is comparatively small. Buffaloes are kept mainly for milk. The average quantity of milk produced by an animal in a year is only 750 lbs. The interval between two lactations is considerably longer than in most countries. Most of the animals are maintained by small holders. Many, particularly in the heavy rainfall areas, are weak and under-developed and produce very little milk. There is some evidence that calf mortality is unreasonably high. The need for trying to improve cattle is not open to question. They play an important role in mixed farming which is essential to the development of agriculture in India.

23-2. It has, however, to be borne in mind that the improvement of cattle is not an end in itself. It is only the means for securing more output from

the animals and greater income from their products. The economics of livestock development, therefore, must be the guide.

23-3. From the nutritional point of view it has been calculated that 8 oz. of whole milk are required *per capita* per diem for a balanced diet. The minimum requirements of milk for the population total 32 million tons. The actual production has been estimated at 23 tons. After allowing 10 per cent of the production for feeding calves, 20.7 million tons are left for human use. Only 27 per cent of this, i.e., 5.6 million tons, are consumed as fluid milk. The greater part of the remainder is converted into ghee and the amount of butter milk available may be reckoned at 12 million tons. If the consumption of whole milk is increased to half the total production, instead of only 27 per cent as at present, it will be necessary to increase production three-fold in order to supply 32 million tons of whole milk annually.

23-4. The requirements of meat, fish and eggs have been reckoned at 6 million tons while the production is only $1\frac{1}{2}$ million tons. There is great need for an increase in fish and egg production.

23-5. The technical problems connected with cattle improvement may be considered under four heads, *viz.*,

- (1) Feeding,
- (2) Breeding,
- (3) Management,
- (4) Disease control.

Thereafter, the marketing of animal products will be considered. Fisheries will be discussed in a separate section.

Feeding

24-1. Cattle feed may be divided into (a) roughages and (b) concentrates. The former include fodder crops, the straws of cultivated crops and grasses. Their total production in British India is estimated at 175 million tons and the requirements work out at 270 million tons. Concentrates include oilcakes, cotton seed, gram, cereal husks and bran. The annual requirements are 15 million tons, and the total quantity available is only 3.7 million tons. Even the latter is used partly as cattle feed and partly as manure. Proper feeding would increase milk production by, at least, 30 per cent.

24-2. *Fodder and straw.* The quantity available is only 60 per cent of requirements. This is only natural as the available land has to be used for producing crops to meet human requirements. The increase of cereal crop production will automatically increase the amount of straw available. More land can only be put under fodder crops specially for cattle where holdings are large and the pressure of the population on the soil is not very intense.

24-3. Millet stalks are an important item in the diet of cattle, and the possibilities of breeding more sugar into them by crossing with sugarcane should be examined. Waste of fodder can be prevented by the use of fodder cutting machines.

24-4. *Grazing.* The amount available is insufficient as regards both yield per acre and acreage. Grass lands which can produce crops are brought under the plough wherever practicable. Another difficulty is that the rainfall being seasonal, grass is available only for a few months in the year; for the rest of the year and particularly during the hot weather, there is little grass to be had.

24-5. The effect of these seasonal deficiencies and gluts should be neutralised as far as possible by hay and silage making. Rotational or controlled grazing helps in this direction too in that it conserves moisture in the ground; overgrazing, with its consequent damage to the grass-plant root, is avoided; the more palatable and superior grasses have a better chance of survival and the herbage is obtained at its most economic stage of growth. The period of rest is determined by the conditions on the spot. It may be as short as a month to six weeks, repeated at intervals, or as long as a year or more. It has been found in practice that if the area is protected from grazing for a year or two, the amount of grass which becomes available from it is increased three or four fold. The system can be worked in forest areas, but is difficult to put on is nearly always necessary.

24-6. If a proportion of the grassland now brought under the plough is devoted to the production of green fodder crops and a system of stall feeding developed, the difficulty arising out of seasonal variation would be offset to a certain extent.

24-7. A plan of improvement should envisage a study of all grazing areas of large dimensions. For each a development scheme would have to be prepared indicating how rotational grazing can be introduced, what grasses grow naturally, and how far reseedling with more nutritive grasses can be introduced. In short, a proper system of grassland management has to be adopted. The question of making more use of the available forest grass as hay should be further explored, and the growing of trees of the fodder species in minor forests, especially in areas of low rainfall, should be encouraged. In view of its valuable nutritional qualities, the growing of dub, grass should be widely extended.

24-8. *Concentrates*. Even if all the oilcakes, cotton seed and bran were available as cattle feed, no oil seeds being exported and no oilcakes used as manure, their production would be only 1/4th of the requirements. An increase in the production of oil seeds has to be part of the agricultural plan.

24-9. *Balanced rations*. Further points for attention in the proper feeding of the animals concern the quality of the feed. A *balanced ration* has to be worked out for each tract, utilising as far as practicable what is locally available. This may have to be suitably treated to make it more nutritious. It may have to be supplemented by special minerals. Salt must be supplied in any case.

24-10. *Recommendations*. (1) The agricultural plan should provide for an adequate increase in the production of fodder and straw.

(2) A development scheme should be drawn up for each large grazing area for proper grassland management, including rotational grazing, reseedling, hay-making, etc.

(3) The agricultural plan should provide for an adequate increase in the production of concentrates, especially oilcakes.

(4) A balanced ration, utilising as far as practicable such feeds as are available locally should be worked out for each tract and should be introduced on a large scale among the villagers.

(5) The growing of trees of fodder species in minor forests, especially in areas of low rainfall, should be encouraged.

(6) Arrangements should be made for the supply to cattle of the necessary mineral supplements and salt.

(7) Water troughs should be constructed in villages.

24-11. *Cost*. Some of the items referred to above form part of the agricultural programme and no cost need be estimated for them here. The non-recurring cost of improving grazing lands may be put down at Rs. 50 crores and a crore of rupees may be provided each year for their maintenance and for the supply of special minerals to correct a shortage where it exists.

Breeding

25-1. Certain breeds of animals are recognised for the possession of certain qualities. The majority of the animals maintained in villages are, however, of mixed breed and referred to as non-descript. They have to be improved by gradual grading up.

25-2. The work may be taken up in selected areas initially. The programme for the purpose may be:

- (i) The removal or castration of all the unselected bulls found in the area.
- (ii) The supply of the requisite number of bulls of an approved breed suitable for the locality.
- (iii) The replacement of these bulls at regular intervals, say every 3 or 4 years, for a period of 15 years.
- (iv) The removal of all the uncastrated male stock produced in the locality in the first 15 years.

(v) The maintenance of a systematic service record of the bulls in the locality and their progeny, if feasible. (This would entail recording the height, girth, length and bone measurement of the male offspring).

25-3. To give effect to a scheme of this sort, arrangements must be made for producing the requisite number of bulls. Allowing 65 cows for one bull,

it means the provision of a million breeding bulls; if they are to be replaced every 4 years, it implies that 250,000 bulls have to be supplied every year. Taking an interval of 15 months for calving, and allowing for the fact that half the offspring will be females, it becomes necessary to maintain on breeding farms no less than 600,000 cows and 10,000 bulls.

25-4. The maintenance of farms on this scale may not be feasible. It is necessary, however, to have at least one farm of 600 cows and 10 bulls for each recognised breed, though, of course, the actual number would depend on the extent to which the particular breed is used in the country. There are at present 40 recognised breeds of cattle and buffaloes and 18 of sheep. It may also be possible to subsidise the production of bulls by approved breeders,

25-5. Each cattle farm would supply a certain number of bulls to key villages which would serve as subsidiary stud farms; the area round these villages would become a selected breeding area where 6,000 cows and 100 bulls of the breed are maintained; the offspring from these areas would be used for grading up other tracts.

25-6. It is necessary to know which breed is most suitable for a particular area. A certain amount of information in this connection is already available at Government and other farms. Where it is lacking, it should be obtained by actual experiments.

25-7. To a certain extent the situation can be met by the introduction of artificial insemination. But the feasibility of its application to a large number of scattered animals has still to be worked out in India. Too much should not be expected from artificial insemination at first, though every effort must be made to spread it as rapidly as possible.

25-8. Whichever method is adopted, it is necessary to make sure that the bulls supplied possess the required characteristics. It is not enough merely to breed for good appearance and conformation. The animals have to be bred for other desirable qualities as well, such as disease resistance, economic feeding, longevity and productivity. Progeny testing should be carried on at farms and the offspring of proved animals should be used as far as practicable.

25-9. This applies even more strongly when farms have to provide animals for dairy herds. The number of such herds is very small at present, but any plan for increased milk production must visualise not only an increase in the number of dairy cattle but also an improvement in their milk yields.

25-10. The same method of work would apply in the breeding of other animals, such as sheep, goats, and poultry.

25-11. *Recommendations.* (1) Some 60 cattle, buffalo and sheep farms, each of 1,200 acres or a greater number of proportionately smaller size, should be established.

(2) The animals maintained at the farms should be selected in the light of the requirements of the neighbouring areas.

(3) If it is not known which breed is most suitable for a particular area, the information should be ascertained by actual experiments.

(4) Animals should be bred at farms for their economic characteristics (e.g., disease resistance, economic feeding, longevity and milk and draught qualities) and progeny testing should be carried out.

(5) As far as practicable, only the progeny of proved bulls should be distributed.

(6) Farm-bred animals should be supplied to selected key villages which would serve as subsidiary stud farms.

(7) Cattle from these key villages should be used for improving the cattle in adjoining breeding areas.

(8) Bulls from such breeding areas should be supplied for at least 15 years for grading up the local cattle in other areas.

(9) During this period all unsuitable males found or produced in such areas should be castrated or removed. Until sufficient farm-bred bulls are available to replace them, the best bulls in the area may be selected and utilised.

villages to towns. In view of the very inadequate milk supplies these arrangements should be begun immediately.

(3) Milk products should be manufactured by improved methods, especially in villages.

(4) Co-operative societies should be established where feasible for the collection and sale of these products.

(5) Adulteration laws should be strictly enforced.

(6) The type of wool required should be produced and proper shearing and grading arranged for.

(7) Hides and skins should be improved by adopting suitable measures against disease control and introducing better methods of flaying and curing.

(8) The meat market should be developed and processing depots established.

(9) Farms should be established for the production of poultry, the distribution of cocks and the collection and sale of eggs.

28-14. *Cost.* The capital expenditure on machinery, buildings, equipment, etc., for supplying milk from villages to meet all the requirements of a small town would be about Rs. 3 lakhs. Taking 500 such towns, the cost would be Rs. 15 crores. Maintenance and replacements may be estimated at one crore of rupees annually. The other matters referred to are mainly a question of organisation and no cost on this account need be reckoned here.

Fisheries

29-1. The fisheries resources of India may be classified as (a) marine and (b) inland. The catch of marine fish is estimated at 450,000 tons a year and almost the whole of it is marketed. The amount produced in inland waters is not known but the quantity marketed is only some 220,000 tons. Its value, however, is double that of the marine fish, i.e., it is four times more expensive.

29-2. With proper arrangements a rapid increase in the production may be expected. Care has to be taken to ensure that the fisherman benefits at least to a reasonable extent from any improvements that may be introduced and that the capital wealth in fisheries is not destroyed by indiscriminate fishing.

29-3. The development of the fisheries resources of India has engaged the attention of the Central and Provincial Governments from time to time in the past. Every now and then, the matter has been taken up energetically, only to be succeeded by a long period of inaction. The record is one of numerous sporadic attempts at improvement with very little practical achievement and general disappointment.

29-4. There are several reasons for this comparative failure. There has been the usual difficulty about the lack of finance. Moreover, in the absence of regular Government machinery at the centre, the matter has usually rested with the enthusiasm of individual officers and so there has been lack of continuity of effort.

29-5. Only some three years ago the first step was taken to remedy this defect when the Imperial Council of Agricultural Research set up a Fish Committee. There has been a certain amount of awakening since then. The Council itself has not been able to take up any constructive work but it has recently suggested the lines along which work should be taken up, and has asked Government to provide the necessary funds.

29-6. The first step is to have a regular organisation. A Fisheries Research Station should be set up, in charge of a Director of Fisheries Research. The aims and objects of the station would be the deepening and widening of the basis of the practical utilisation of the fish resources of India and the conduct of research with this object. Its functions would be:

(i) to plan, co-ordinate, conduct and guide all relevant scientific research in the country on the ecology and bionomics of Indian fishes and other aquatic products, with a view to elucidate factors which influence their growth, movements, periods fluctuations and development,

(ii) to conduct an investigation into the present state of commercial fisheries in India with a view to open and develop new grounds and new objects of fishery,

(iii) to carry out research into the technological aspects of the fishing industry,

(iv) to devise suitable means for the proper marketing of the produce, and
(v) to ensure the training of research and development personnel, both by the station itself and in co-operation with the fishery departments, in the Provinces and States.

29-7. The Station would operate in three sections: (i) Biological, (ii) Physico-chemical, including hydrography and (iii) Technological.

29-8. This Station would be primarily a research organisation. It could work under the Government of India, in which case, like the Imperial Agricultural Research Institute and the Imperial Veterinary Research Institute, it would be largely divorced from development. In accordance with the general plan of research, it should be treated as a Commodity Research Station attached to and managed by an Indian Central Fish Committee, which would attend to both Research and Extension. It would have to obtain its finance from a Government grant.

29-9. Pending the establishment of a station, steps should be taken to set up training centres where short courses to meet immediate requirements may be given to the extension staff.

29-10. *Marine fisheries.* The most profitable trawl grounds are said to lie between 15 and 50 fathoms, a depth which is better suited to the Danish seine than to a steam trawl. It has been suggested that sailing boats equipped with an auxiliary motor, or in the alternative, a 16-28 tons motor boat equipped with a 35 H. P. engine should be used.

29-11. Experiments should be carried out with the purse seine, drift net and long lines. In fact, there is need for experiment before any big scheme can be launched. Investigations at what may be called the pilot plant stage should be carried out in the first instance. It will only be as a result of these investigations that a full-fledged scheme of development can be drawn up.

29-12. For the present, the most important problem seems to be not so much that of catching fish as of gutting them while in transit and conveying them as quickly as possible to port where they can be kept in cold storage, pending consumption. These carrier boats should have powerful engines and, if possible, insulated holds for iced fish. The question of transport in cold storage by rail or otherwise will also have to be considered.

29-13. *Inland fisheries.* It is necessary to carry out investigations on inland fish to find out (i) the usual time of day when eggs are laid, (ii) the number of eggs laid and fertilised, (iii) the duration of the egg store, (iv) the food, habits and behaviour of the fry, (v) the kind of food which accelerates their growth, and so on.

29-14. This has to be supplemented by development work (i) to ascertain where the breeding grounds are situated, (ii) to establish hatcheries, (iii) to build up a regular fish fry trade, (iv) to improve village tanks so that they can stock more fish, (v) to arrange for a passage for fish in canal headworks, (vi) to prevent damage to fish life by sullage water and (vii) to establish commercial fish farms or tanks as a demonstration. Questions connected with the proper marketing of the fish, e.g., in crushed ice in containers, will also have to be looked into. The prohibition of fishing at certain seasons will also be necessary.

29-15. As an immediate practical measure it has been suggested that the young of certain types of fish (rohu, catla, mrigal, etc.) which are available in large quantities in flooded rice fields may be carefully collected and planted in tanks, ponds and lakes.

29-16. The main problem in connection with fish is its marketing. This is particularly true about estuarine fish in Bengal. The fishermen are so completely in the hands of a powerful ring of middlemen to whom they owe money, that improvements in marketing are not feasible, except in so far as they help the middlemen themselves. The whole problem needs careful study.

29-17. There are certain industries connected with fisheries development to which proper attention must be paid. The possibilities of introducing fishmeal as food for cattle should be carefully explored. Similarly, the production of
v Industries connected with the

20-18. *Recommendations.* (1) An Indian Central Fish Committee should be established.

(2) A Fisheries Research Station should be set up at an early date in two sections, one for marine and the other for inland fisheries

(3) Work on a pilot plant scale should be carried out in respect of the best methods of catching marine fish.

(4) Arrangements should be made for the rapid transport of fish after capture to the port, for the provision of cold storage facilities and for iced transport to consuming centres.

(5) Inland fisheries should be developed by setting up a series of Government ponds where fry can be raised to the fingerling stage, for their transport and for the stocking of selected tanks and reservoirs with them.

(6) Facilities in the shape of boats, nets, etc. should be given to fishermen where required.

(7) Proper arrangements including rapid transport, cold storage and freedom from too much dependence on middlemen should be made for the marketing and sale of fish.

20-19. *Cost.* The establishment of an Indian Central Fish Committee to attend adequately to research, extension and training is estimated to cost ten lakhs of rupees a year. The experimental work on marine fisheries with necessary staff and equipment for 3 years would cost Rs. 3 lakhs only. Once that stage is passed, however, a number of seines and motor boats will be required. Preliminary investigations and surveys to develop inland fisheries would cost another Rs. 2 lakhs. The probable cost of development work cannot be estimated at present.

20-20. The non-recurring cost of a Fisheries Research Station which would have to be in two parts, one for marine fisheries and the other for estuarine and inland fisheries, has been estimated at approximately Rs. 20 lakhs, not including the cost of research trawlers. The recurring cost is expected to be about Rs. 5 lakhs a year.

CHAPTER V.—ORGANISATION: PLANT HUSBANDRY

Scope of Organisation

30-1. In planning a suitable agricultural organisation for India, one has to build, as far as possible, on the existing structure. It is to be presumed that the money needed will be forthcoming and that trained men will be available in sufficient numbers, failing which steps will be taken to train an adequate number.

30-2. At the same time, it must be borne in mind that agricultural knowledge is constantly expanding. The staff which may be adequate today may be wholly insufficient in five years' time. In other words, it is not possible to indicate an ideal organisation that would be suitable for all time. All that can be done is to suggest what would be suitable under existing conditions. Expansion would be necessary from time to time as knowledge advances.

30-3. In building up a suitable organisation, it has to be realised that it will be called upon to discharge three distinct functions. (1) It has to carry on research, both fundamental and applied. (2) It has to ensure, by propaganda, demonstration or other means, that the practical results of applied research are taken up by agriculturists. (3) It has to impart training or education at schools and colleges.

Research

31-1. Problems for research arise in three ways. (1) The agriculturist or his adviser notices something wrong and brings it to the notice of the scientist to find the cause and suggest a remedy. (2) The research worker himself often comes upon problems which he feels ought to be further investigated. (3) Often certain problems of national interest arise and are set to the scientists for solution as soon as practicable.

31-2. Whatever its source, research involves three types of investigation. (1) Fundamental or basic research, which is of long range nature and is aimed at understanding the underlying causes of natural phenomena. (2) Applied research, which is often of an empirical nature, tries to find special remedies for

specific problems. (8) Pilot or developmental research tries out the preliminary results of applied research on a field scale to ascertain their general applicability, before they are passed on to the Extension Staff. It is often because of lack of adequate attention to this type of research that so much of the work done fails to progress to any practical end. There can, of course, be no sharp line of demarcation between these types of research. But they have to be borne in mind when considering the question of staff needs for carrying out research. For orderly progress, a proper balance has to be maintained between the different kinds of research.

31-3. The approach to agricultural research has to be from two points of view. The older method is to have a section for dealing with each branch of agricultural science, such as Agronomy, Botany, Chemistry, Entomology, Mycology, Physiology, Soil Science, etc. A recent tendency is to take up a particular commodity or group of commodities for special study from all aspects. Actually both types of study are needed. The Director of a Commodity Research Station would have his staff of scientists all working together on the particular commodity, thereby securing what may be referred to as horizontal co-ordination. But there has also to be vertical co-ordination between the entomologists working on the different commodities, the chemists working at the various research stations, and so on.

31-4. For vertical co-ordination there is already a nucleus in the Imperial Agricultural Research Institute. It should be developed into a Federal Institute whose heads of sections would act as co-ordinators of research in their respective sciences throughout the country. Their function would be purely co-ordination and not supervision. For this purpose they should be men of calibre, status, scientific reputation and attainment which will command respect of all.

31-5. The Institute would also have to work in close collaboration with the Universities. Special lines of research in each of the major agricultural sciences may be assigned for study and research to particular Universities which have facilities for the purpose. Taking plant diseases, the special study of rusts may go to one University, of bacteria to another; of virus to a third. Thus the Institute and the Universities between them would make a thorough study of all the branches of each science. Arrangements must be made for creating chairs in suitable scientific subjects and for research scholarships to be given to promising students in the universities; liberal funds should be provided for these purposes.

31-6. If there exist a federal institute working with the universities and dealing with each science and a number of federal research stations each dealing with a particular commodity or group of commodities, the question may well be asked what research is left for the provinces. Actually, as the federal work expands, the provincial work will increase with it.

31-7. This can be best illustrated by giving an example. The federal commodity research station evolves a particular crop variety which is resistant to disease. It then passes this variety to the various provincial botanists who utilise it, by hybridisation or otherwise, for producing new varieties which are suitable for their conditions.

31-8. Nor will the traffic be all one way. The provincial officers who are in closer touch with the cultivators will come across many local problems. Some of them they themselves will have to tackle. Others will be passed on by them for more intensive study to the Institute or the Commodity Station, as the case may be. The detailed distribution of work will have to be prepared separately in respect of each commodity and each science, by special committees appointed for the purpose.

31-9. In fact, the provincial headquarters' research work will be the counterpart of the federal institute. It also will have a scientist in charge of each important scientific Section. The Head of the Provincial Research Station will co-ordinate horizontally the work of the Station, while vertical co-ordination between similar sections of the different provinces will be effected by the Federal Council.

31-10. The organisation and staff needed for a federal institute, for federal commodity research stations and for the federal headquarters, as also for a provincial research and experiment station, are indicated roughly in the following sections.

31-11. *Recommendations.* (1) To ensure proper co-ordination, Research must be approached from two aspects—(a) the horizontal in which all angles of a commodity or a problem are investigated at the same station by a staff representing all the various sciences involved, and (b) the vertical which co-ordinates the work of all those who are dealing with each individual science.

(2) The Imperial Agricultural Research Institute should be developed into a Federal Institute. One duty of its Heads of Sections would be to act as vertical co-ordinators of their respective sciences. Commodity Research Stations would be the horizontal co-ordinators regarding their own commodities.

(3) Special lines of research in each major agricultural science should be assigned for study to particular universities which possess facilities. Research scholarship should be provided. In addition funds should be set apart for the endowment of chairs in scientific subjects.

(4) Provincial headquarters research stations should be the local counterparts of the federal institute.

The Federal Agricultural Research Institute

32-1. The Imperial Agricultural Research Institute has at present six sections, viz. (1) Agriculture, (2) Botany, (3) Chemistry, (4) Entomology, (5) Mycology, and (6) Sugarcane Breeding which is located at Coimbatore. The post of Director is held by the head of one of the Sections, but there is a separate office for the Director. In addition, there are five sub-stations, viz. (1) Karnal, (2) Pusa, (3) Simla, (4) Guntur, and (5) Karachi (for locusts).

32-2. The Institute should have a whole-time, instead of a part-time, Director who can co-ordinate all the research work at the Institute and its Sub-stations. He should be relieved of routine administrative duties so that he can devote his time and attention to the scientific aspect of the work. The Director should have the assistance of a Joint or Deputy Director, who will be head of one of the Sections and receive a special pay. This association of a senior officer with direction will facilitate disposal of work during the Director's absence from headquarters, and will also ensure continuity of policy when he goes on leave, etc.

32-3. The so-called Agriculture Section appears to be a composite section dealing with (1) Agronomy, (2) Cattle, (3) Engineering, and (4) Statistics, all under the Imperial Agriculturist.

32-4. Statistics are applicable to all sections of the Institute and not merely to Agronomy. Hence it is suggested that the Statistical Branch should be converted into a section under a class I officer and the subordinate staff should be strengthened.

32-5. Agricultural engineering is not receiving the attention it deserves. There should be a separate section dealing with it, tackling, on the one hand, problems connected with mechanisation and implements and, on the other, drainage and soil conservation. Special soil conservation staff would also be needed for preparing plans of work and recommending or taking the necessary measures, as the case be, in respect of the watersheds in different parts of the country, specially those which cover more than one administrative unit.

32-6. In general, cattle breeding and dairying appear to be fitter for an Animal Husbandry Institute than for an Agricultural Institute. The maintenance of a cattle herd at the latter can be justified as an adjunct of mixed farming. This aspect should be emphasized in the programme of the Institute.

32-7. If Statistics and Engineering become separate sections and cattle are relegated to their proper position, the section will become an Agronomy Section for dealing with manurial, rotational and cultural practices. There is great need for laying out properly planned agronomic experiments all over the country.

32-8. The question of a Section of Agricultural Economics may well be considered in this connection. The economic side of agriculture is usually neglected, though it is of outstanding importance. It may be combined with Statistics to form a separate section of the Institute.

32-9. The Botany Section should, it seems, confine itself to Genetics, Cytology, Physiology, Anatomy, and Morphology in general.

32-10. The work of the Chemical Section may be divided into: (1) Soil Physics, dealing with the physical structure of the soil, capacity for retaining moisture, etc., (2) Soil Chemistry, Inorganic, i.e. the minerals in the soil, (3) Soil Chemistry, Organic, i.e., the organic constituents of the soil, (4) Soil Biology, i.e. the bacteriological constituents of the soil, and (5) Plant Chemistry, i.e. the constitution of the plants grown with reference to the quantity and quality of their juice, protein content, etc., and (6) Food Chemistry. It may be necessary to add a section for carrying out soil surveys in areas where data are lacking, in continuation of the soil survey review which the Imperial Council of Agricultural Research is financing at present.

32-11. The Imperial Entomologist has, in addition to his other duties, to look after the locust work which will be referred to later and to guide and direct work on two schemes financed by the Imperial Council of Agricultural Research, viz. one on sugarcane which may well be transferred to the sugarcane research station, provided the necessary facilities are available, and the other on storage of *jowar*, which again should go to the commodity research station dealing with *jowar*.

32-12. The Mycology Section appears to be weak, when compared with Entomology and needs strengthening. In addition, there are three schemes financed by the Imperial Council of Agricultural Research. There is one assistant to work on type cultures of fungi. This should really form part of the normal work of the Institute. There is a Sugarcane Diseases Scheme which should go to the Sugarcane Research Station, provided the necessary facilities are available there. Finally, there is a scheme for seed certification of potatoes which will need to be considerably expanded shortly, but it should form part of the work of a Potato Research Station.

32-13. The Sugarcane Station at Coimbatore should cease to be part of the Federal Agricultural Research Institute and should become the breeding centre of the Sugarcane Commodity Research Station. The scope and function of the sub-station at Karnal need to be carefully gone into. The need for a sub-station at Pusa also should be looked into. The Simla sub-station, dealing with both wheat and potatoes, is financed by the Imperial Council of Agricultural Research. This should form part of the corresponding commodity research station. The Guntur sub-station for tobacco is financed by the Imperial Council of Agricultural Research and will probably be taken over shortly by the Tobacco Committee.

32-14. As the staff of officers must be experts in their own line, it would probably be advantageous if they are all Class I officers.

32-15. Again, the Head of a Section will have to tour extensively to secure co-ordination and maintain the necessary degree of collaboration with the universities, the commodity research stations and the provincial research stations. Hence it would be advisable in most cases to have a Deputy Head who will ordinarily be the most senior class I officer in the Section.

32-16. Adequate provision for travelling allowance should be made for this purpose in the Institute budget, as also for calling occasional conferences of scientists.

32-17. There should be a Bureau attached to each Section. It should collect all the information in respect of its own particular science and should bring it from time to time to the notice of all concerned. The Head of the Section should be ultimately responsible for this work.

32-18. The Institute should be attached to the Imperial Council of Agricultural Research. If for any reason this cannot be done, at least the Bureaux should be attached and the services of the Heads of Sections should be available to the Imperial Council of Agricultural Research for consultation.

32-19. In short, the Institute will have to carry on much of its work with the co-operation of and in collaboration with (1) the Universities, (2) the Commodity Research Stations, and (3) the Provincial Research Stations. It will also have to maintain special staff for particular kinds of work, *e.g.* locusts and Bureaux which will serve as clearing houses of information.

32-20. There should be seven Sections at the Institute, *vis.* (i) Agronomy, (ii) Botany, (iii) Soil Science and Agricultural Chemistry, (iv) Agriculture Economics and Statistics, (v) Agricultural Engineering, (vi) Entomology, and (vii) Mycology.

32-21. The office of the Director should be in the charge of a Secretary in the scale of Rs. 600-25-800. He should relieve the Director and other experts at the Institute of routine office administration. The Central Office should work in two Branches of Establishment and Finance, each in charge of a Superintendent with an adequate number of I Division Assistants, II Division Clerks and Routine Clerks, on rates of pay sanctioned for attached offices. Including the Librarian, in Class II service, and his staff, the Artist and Estate Establishments, and such charges as those for irrigation and filtered water, electric power, gas supply, etc., the annual cost of the central administration will be about Rs. 3,00,000.

32-22. In view of the responsibilities, status and scientific attainments of Heads of Sections the scale of pay attached to these posts should be Rs. 1,000-50-1,500, which may be treated as a Selection Grade of the Class I Service.

32-23. The Research Assistants at the Institute should receive a minimum pay of Rs. 150 rising by Rs. 10 increments to Rs. 350.

32-24. The Agronomy Section should consist of the Head, four Class I Officers (Mixed Farming Expert, 3 Experimentalists), and five Class II officers.

32-25. The Botany Section should consist of the Head, five Class I Officers (two Geneticists, Cytologist, Physiologist, Systematist) and four Class II Officers, one of the latter being a Post-Graduate Instructor. After providing for an adequate number of subordinates and working expenses the sectional budget is estimated at Rs. 1,25,000.

32-26. The staff of the Section of Soil Science and Agricultural Chemistry should consist of the Head, seven Class I Officers (Physical Chemist, Soil Chemist—Inorganic, Soil Chemist—Organic, Microbiologist, Biochemist, Agr. Chemist, and Soil Survey Officer) and an equal number of Class II officers, one of the latter being a Post-Graduate Instructor. After providing for an adequate number of subordinates and working expenses, the sectional budget is estimated at Rs. 1,75,000.

32-27. The Section of Economics and Statistics should consist of the Head, who will be an Economist, two Class I Officers (one Economist and one Statistician) and one Class II officer for statistics. After providing for an adequate number of subordinates and working expenses, the sectional budget is estimated at Rs. 60,000.

32-28. The staff of the Engineering Section may consist of the Head, one Class I and two Class II officers. The cost of the section is estimated at Rs. 1,75,000. This includes provision for the salaries of subordinates and working expenses.

32-29. The Entomology Section should consist of the Head, five Class I officers (Systematist, Taxicologist, Parasitologist, Epidemio'logist and Termite Control Entomologist) and an equal number of Class II officers, one of the latter being a Post-Graduate Instructor. Providing for an adequate number of subordinates and working expenses, the sectional budget is estimated at Rs. 1,40,000.

32-30. The locust staff has to be maintained at such strength as circumstances may require from time to time. The 'peace' strength of the Locust Warning Organisation should be one Class I Officer and four Class II officers (one each for Baluchistan, Sind and Rajputana Desert Areas and one at Headquarters of the Imperial Entomologist). The annual cost is estimated at Rs. 75,000.

32-31. The staff of the Mycology Section will consist of the Head, five class I officers [Systematist, Plant Pathologist, Plant Pathologist (Virus), Plant Bacteriologist, Industrial Mycologist] and five Class II officers, one of the latter being a Post-Graduate Instructor. The sectional budget is estimated at Rs. 1,20,000.

32-32. Pusa, if required, might serve as a sub-station for all sections for the Sub-Tropical Zone: if so, the staff will have to be strengthened at a cost of Rs. 38,000 annually.

32-33. If similar combined sub-stations for the Temperate and Tropical Zones—preferably at Simla and at Coimbatore—are required, they will cost about a lakh of rupees.

32-34. The Sugarcane Breeding Section should be taken over by the Indian Central Sugarcane Committee.

32-35. The development of these sections to the extent required to assume the role to be assigned to them will require an annual expenditure of Rs. 25 lakhs. But as men of requisite qualifications will not be immediately available in sufficient numbers, the immediate target is taken as Rs. 15 lakhs. This immediate target will have to be raised ultimately to at least Rs. 25 lakhs under a five-year development plan.

32-36. Apart from this recurring expenditure, a block grant of Rs. 40 lakhs will have to be provided for capital expenditure, of which Rs. 25 lakhs will be required immediately to start new lines of work, e.g. Engineering. This will be spent on additional workshop and laboratory accommodation (8 lakhs), equipment for workshop, laboratories and library (8 lakhs), hostel for students and rest house for research workers (1 lakh), residences for members of staff (13 lakhs).

32-37. *Recommendations.* (1) The Federal Agricultural Research Institute should be attached to the Imperial Council of Agricultural Research.

(2) There should be a whole-time Director, assisted by a Joint or Deputy Director who may be the Head of one of the Sections.

(3) The office should be under the charge of a Secretary assisted by Superintendents for Establishment and Finance.

(4) There should be seven principal Sections at the Institute. They should be staffed by 36 Class I and 81 Class II officers.

(5) To each Section there should be attached a bureau for the collection and dissemination of all information regarding its particular science.

(6) Heads of Sections should be on a scale of Rs. 1000-50-1500.

(7) Apart from the Head, each Section should have a deputy head who would normally be its most senior Class I member.

(8) Research assistants should receive a minimum pay of Rs. 150 per mensem in a scale rising to Rs. 350.

(9) Special soil survey staff may be required for work on watersheds which cover more than one administrative unit.

(10) Cattle breeding and dairying should be assigned to an Animal Husbandry Institute, except in so far as an herd is necessary as an adjunct of mixed farming.

(11) The Institute must work in close collaboration with universities, commodity research stations and provincial research organisations.

(12) Agricultural and animal husbandry museums should be established at the central institutes. Connected with them there should be a very competent library service.

32-38. *Cost.* As an immediate target the recurring expenditure on the Institute should be raised to Rs. 15 lakhs per annum, with a gradual increase to Rs. 25 lakhs under a five-year development plan. Capital expenditure of Rs. 25 lakhs will be necessary immediately increasing to Rs. 40 lakhs in five years.

Commodity Research Stations

33-1. A central commodity research station would normally investigate problems of a fundamental nature connected with the particular commodity

and would carry on work of common utility to a number of provinces and States or for large tracts. Most fundamental problems are the same wherever a plant grows and they can best be studied by a central station.

33-2. A central station, however, obviously cannot cater for all conditions. Climatic and soil conditions differ from tract to tract. Certain areas are unsuitable in various ways for some plants. Sugarcane, for instance, flowers in the South but is mostly cultivated in the North. Potato seed has to be produced high up in the hills if the potatoes grown in the plains are to be free from virus. There are some vegetables which will not set seed in the plains at all. It is necessary to have a number of regional experimental stations in different parts of the country for ascertaining the most suitable varietal, cultural and manurial practices for each tract. These again may have to be supplemented by sub-stations, one in each soil type within the tract. They will work under the general guidance of the central station.

33-3. The question arises why, if there are wide differences from tract to tract, the work should not be left entirely to the provinces. The answer is that there are certain basic matters in which work should be carried on by the federal authority. If, for instance, every important province or State were to have a separate farm for breeding sugarcane in South India or for producing disease-free potatoes in North India in the Himalayas, the position would be impossible. The very object of federation is to eliminate such waste of effort and help all concerned.

33-4. The feasibility of carrying out the work contemplated at the various experimental stations depends on the amount of land and other facilities available and each case has to be considered on its merits. Where a province is willing to take up this work, it may well be encouraged to do so.

33-5. Similarly, the exact relations between the federal central commodity research station and its regional experimental stations on the one hand and the provincial stations on the other will have to be settled in each individual case. Mutual collaboration is essential.

33-6. Broadly speaking, a Central Commodity Research Station should have its own Director, who should be a senior officer. Under him, he would have a team of Class I officers, for Agronomy, Botany, Chemistry (Soils), Economics (including Statistics), Entomology, Mycology, Physiology and others, as circumstances may require. There would also be the necessary subordinate staff. In this way the problems of a commodity would be examined from all aspects and solutions be suggested for further examination by provincial stations.

33-7. A regional experimental station would need an experienced Class I officer-in-charge. The staff would consist of an agronomist, a botanist, an entomologist, a mycologist, a chemist and possibly an engineer, with the required subordinate staff.

33-8. A sub-station for field experimental work is best provided by the provinces. It needs only a suitable agronomic officer with subordinate assistants.

33-9. The agricultural commodities for which such stations seem to be necessary, apart from Cotton, Jute, Tobacco, Sugarcane, Tea and Coffee, for which stations have already been provided, are Rice, other Foodgrains, Vegetables, Potatoes, Fruits, Medicinal Plants, Plantation Products, Oilseeds and Grasses. Rice, Oilseeds, Potatoes and Vegetables seem the most important at present.

33-10. Each Commodity Research Station should be linked up with an Indian Central Committee for that commodity, along the lines of the Cotton and Jute Committees.

33-11. *Recommendations*:- (1) Central Commodity Research Stations should be established for a number of crops covering food grains, grasses, fruits, vegetables, oilseeds, medicinal plants and plantation products.

(2) Each such station should be linked up with an Indian Central Committee for that Commodity.

(3) Each Central Research Station should be supported by the necessary regional research stations and sub-stations.

(4) Each Central Station should be staffed by a team of Class I officers representing each of the main sciences applied to agriculture and with the necessary subordinates.

(5) The Federal Council of Agriculture and Animal Husbandry should co-ordinate the work of the commodity research stations.

(6) Each regional station will need a staff of about six officers apart from the senior officer at its head. The usual subordinates will be required.

(7) A sub-station needs only an agronomist and subordinates.

83-12. *Cost.* The central regional and sub-stations for research on tobacco have been estimated to cost Rs. 4 lakhs annually. This does not include capital expenditure on land and buildings. Nor has allowance been made for financing improved marketing, additional extension activities and other items which will be necessary and which may cost Rs. 6 lakhs per annum. Hence for each Commodity Committee and its work there should be an annual provision of Rs. 10 lakhs. Ten such Committees will cost Rs. one crore annually. In many cases the cost of Commodity Research Organisations can be met by cesses or duties on the commodities concerned.

Federal Headquarters

84-1. It is necessary to have at the centre with its own portfolio a Federal Department of Agriculture and Animal Husbandry which would tackle the manifold problems connected with the improvement and development of these sciences. It must be in a position to ensure that effective action is taken and financial assistance rendered when and wherever necessary.

84-2. If the Agricultural Institute and the various Commodity Research Stations are attached to the Federal Organisation (i.e. the I.O.A.R.) and if the latter has enough money to give grants to Universities, scholarships for training, and grants to provincial research stations for keeping them in line with the all-India programme of work, very little change would be needed in the present organisation.

84-3. Extension is primarily the function of the provinces and States. But there should be a central body which should review the action taken by all administrations to ensure that the results of research reach the cultivators, and to give help where needed. Hence, extension must come within the purview of the Council, which must develop into a Federal Council of Agriculture and Animal Husbandry and form an integral part of the Federal Department dealing with both Research and Development.

84-4. The expert staff at headquarters would also have to be increased. The Agricultural Production Adviser would be attached to the Council and would really become Agricultural Extension Commissioner, as distinct from the Agricultural Research Commissioner. Or, there may be two advisers—one for research and the other for development—under one Agricultural Commissioner. An adviser for agricultural economics would also be needed, unless a section for this subject is established at the Institute. Similarly, a Soil Conservation Officer and a Minor Works Engineer may be required as liaison officers to deal with the Land Utilisation Board that should be set up at the centre.

84-5. If, however, the Central Government desire to retain the control of the Institute directly under themselves and will not agree to expand the work of the Council in order to enable it to tackle development effectively, the only course is for the Council to start its own Bureaux and its own Commodity Research Stations, as and when funds become available.

84-6. The federal organisation should be in a position to make grants to universities and to provinces and States for the conduct of special lines of research or for other purposes in which it may be considered necessary to assist financially from time to time. For this purpose an annual provision of Rs. 25 lakhs should be made.

84-7. *Recommendations.* (1) A Federal Department of Agriculture and Animal Husbandry, with its own portfolio, should be established at the Centre.

(2) The Imperial Council of Agricultural Research should become a Federal Council of Agriculture and Animal Husbandry dealing with both research and development.

(3) The headquarters expert staff of the Council should be strengthened.

34-8. *Cost.* It is difficult to work out the cost of these proposals, even approximately. Five additional senior officers at headquarters to help the provinces and to advise and guide all concerned would mean about 2½ lakhs of rupees a year. If, in addition, the Council has to maintain its own bureaux, this would involve a further 2½ lakhs a year. Thus, at a rough guess, the total expenditure will be Rs. 5 lakhs annually, apart from the sum of Rs. 75 lakhs for grants to outside bodies and administrations.

Provincial Research Stations

35-1. The organisation of a provincial headquarters research and experimental station (such as is often attached to an Agricultural College) would be similar in many respects to that of the Federal Institute. There would, however, be important differences.

35-2. Such a station should be in charge of a senior whole-time officer, who would have a team of Class I specialist officers. The research staff of a provincial headquarters station would be more or less on the same pattern as the Central Institute.

35-3. In addition, there should at least be one experimental farm for each division, to provide facilities for experiments under different soil and climatic conditions. It should be situated, if possible, on land which is representative of different degrees of fertility prevailing in the division. Normally, it would be under the charge of the Deputy Director of Agriculture of the division.

35-4. It would be necessary to have at each provincial headquarters research and experiment station, about 9 Class I officers and other Class II officers. Each of them would need the usual subordinate staff and a large amount for contingencies.

35-5. *Recommendations.* (1) The organisation of the provincial headquarters research and experiment station should follow generally that of the federal institute.

(2) Each division should have an experimental farm.

35-6. *Cost.* A full-fledged provincial research station would cost about Rs. 2½ lakhs a year. Ten such stations would cost Rs. 25 lakhs annually. Allowing Rs. 35 lakhs for 50 divisional experimental farms, the total cost for British India would be Rs. 60 lakhs.

Provincial Extension Work

36-1. The ultimate object of all extension work is, on the one hand, to introduce the results of research on a wide scale among farmers so as to enable them to get higher returns and, on the other, to ascertain and communicate their difficulties to the research workers for finding a solution or, if the solution is known, to communicate it to the farmers concerned.

36-2. For this purpose it is necessary to have facilities where the results obtained at a commodity research station, a provincial research station or a divisional research station may be tried out to ensure that they suit local conditions or to modify them, where necessary.

36-3. Experimental farms have to be supplemented by demonstrations on the fields of cultivators. In some cases it may be necessary to have small demonstration farms worked by progressive farmers on lines established as a result of experiments, in order to ascertain the economics, and to convince local cultivators of the applicability of the results of a piece of research to their own conditions.

36-4. Where farmers are educated, a small extension staff is able to supply the necessary help. With a large number of small farmers, most of whom are illiterate, as in India, the importance of extension work is much greater. The staff must carry out propaganda and give demonstrations of improved methods, often supplemented by exhibitions and the award of prizes. The advisability of establishing agricultural museums also needs to be considered in this connection.

36-5. Importance is attached to the part which a mobile cinema can play in the dissemination of useful results of research amongst cultivators and in their education generally. One such cinema would be required per district.

36-6. The provision of a mobile cinema service automatically necessitates the setting up of a central organisation for the preparation of films on a linguistic basis.

36-7. *Recommendations.* (1) Facilities must be provided for trying out the local applicability of results obtained at Central and other research stations.

(2) Demonstrations of improved methods, practices, seeds, etc. are essential on their own fields to convince cultivators of the value under their own conditions of results obtained at Government experimental farms.

(3) The mobile cinema should be used freely not only in educating the cultivator in improved methods of farm husbandry but also for his general uplift.

(4) A central organisation for the preparation of suitable films should be set up. At this studio facilities should also be provided for the training of extension staff in the art of propaganda.

36-8. *Cost.* The cost of facilities for local demonstrations may be estimated at Rs. 5 lakhs annually per province or Rs. 50 lakhs a year for British India. The provision of one fully equipped mobile cinema per district and the establishment of a suitably equipped studio for the preparation of films may cost Rs. 25 lakhs, whilst the annual expenditure on maintenance and the preparation of films may amount to Rs. 10 lakhs.

Extension Staff

37-1. A tentative scheme for the organisation of the extension work in a province is given in the following paragraphs. It has, however, to be borne in mind that it is not feasible to have a uniform pattern for all areas. The exact organisation for each tract has to be worked out by the local staff, bearing in mind local conditions. What may be very well for North India may be quite unsuitable for the Deccan. But perhaps the organisation suggested might serve as a basis on which, after modification where necessary, a suitable structure can be erected. It is of supreme importance to obtain the right type of men for this work.

37-2. The only way in which the work of extension can be satisfactorily tackled is to treat the village as a unit. Each village should have its own co-operative or other organisation which would serve as a link between the experts and the farmers. The organisation of better farming societies in rural areas should be entrusted to the agricultural departments. With an educated farmer working as the Secretary of such an association, or as a "Village Guide", the task of the extension workers is considerably lightened. They then have to deal with 400,000 village guides in British India instead of having to explain matters to 46 million individual farmers.

37-3. The village guide who will act as a link between the villagers and the various development departments should receive some practical training at the divisional or district farms in connection with the matters which he has to communicate to the villagers. He should be able to do things himself and to demonstrate the practices which are useful to the farmers. He should be either a whole-time employee of Government or of the Co-operative Society or a cultivator in the village itself who could give his part-time services as a guide.

37-4. If it is not intended to cut adrift from the agricultural organisation existing in many parts of the country, the provincial and State extension staff might be on the scale of one fieldman (known in some places as a Kamdar, Kamdar, Mukaddam, Maistri, etc.) for each Union, one agricultural demonstrator or non-graduate assistant for each circle, one inspector or graduate assistant for each Tahsil, one Superintendent or Assistant Director for each district, and one Deputy Director of Agriculture for each division. In some areas, where non-graduate assistants are not normally employed, an average subordinate staff of one Mukaddam or Kamdar per circle and two graduate assistants per Tahsil is considered sufficient.

37-5. On this basis the total extension staff needed for British India would be:—

Village Guides	400,000	400,000	Graduate assistants	1,350	2,350
Fieldmen or Mukaddams	20,000	5,000	Superintendents or		
Non-graduate keepers	5,000	Nil	Assistant Directors	250	250
Seed Store assistants	5,000 or	3,000	Deputy Directors	50	50

37-6. The chief units in this hierarchy are the circle non-graduate demonstrators. They have to explain matters to the village guides and find out their difficulties. They have to introduce new ideas and practices among the cultivators by demonstration and propaganda. They have to lay out simple agronomic tests on the fields of cultivators.

37-7. Apart from the staff required for the farm and for ordinary extension work, there would be in each division a number of specialised assistants in the senior-most non-gazetted grade to deal with special problems connected with agronomy, soil, botany, entomology, mycology, horticulture, engineering. For technical guidance and control they would work under the provincial specialist in the science concerned.

37-8. These senior assistants would be the link between the scientific officers and the cultivators. Each would advise and assist in regard to the more technical aspects of his particular science or subject.

37-9. Arrangements have also to be made by the extension staff for the supply of seed, manure, implements, etc. There should be for this purpose a seed farm attached to each experimental farm where nucleus pedigree seed could be raised under the supervision of the botanical assistant. This would then be further multiplied by A and B grade growers under the supervision of the extension staff. Or, the first stage of further multiplication may be carried out at Government sub-stations before the seed is given to A and B grade growers.

37-10. The whole of the seed given out to A and B grade growers would have to be purchased at a premium. The aim should be to have about 500 maunds of seed produced for each circle by B grade growers: its produce which may be called C grade seed should be purchased either by a co-operative society for the circle or by licensed seed merchants and stored for distribution to the farmers.

37-11. Special staff would be needed for collecting the seed and storing it properly. One seed store-keeper would be needed for this purpose for each circle. In addition to the charge of the circle seed store, he may also deal with the distribution of implements and manures, though, if the work develops, a separate man may be needed for each of these activities.

37-12. In course of time, it may be possible to have in every district the organisation at present visualised for each division. The division unit would then disappear. There would then be the provincial organisation, the district organisation, the circle organisation and the village organisation instead of 7 as at present (*viz.* the province, division, district, tahsil, circle, union and village).

37-13. The cost may be worked out approximately as follows:—Some 400,000 part-time village guides at Rs. 200 each per annum would cost about Rs. 8 crores. If they are to be full-time men, this cost would be doubled. In certain areas it may be possible for village co-operative societies to meet part of the cost of these guides. The circle demonstrator would cost roughly Rs. 1,000 a year and the circle seed store-keeper about Rs. 800. Thus, if no Union fieldmen are appointed, the cost would be Rs. 1,800 a year. The appointment of Union fieldmen would add a further Rs. 1,500, making Rs. 3,300 per annum per circle. Including subsidies for seed purchase and other incidents, the cost may be put at Rs. 4,000 a year. On the basis of 5,000 circles the cost would amount to about Rs. 2 crores a year.

37-14. The tahsil staff would cost Rs. 2,500 a year and as there are 1,000 tahsils, this means Rs. 25 lakhs. The district superintendent would cost Rs. 5,000 a year and for 240 districts this totals Rs. 12 lakhs a year. Allowing for miscellaneous items, the tahsil and district staff between them would cost Rs. 40 lakhs a year.

37-15. The divisional staff would cost not less than Rs. 75,000 a year. The cost of running the experimental farm has been included under research. The seed farm should be self supporting, but as the main idea is to supply seed at market price and bear the loss, a sum of at least Rs. 10,000 should be provided. Thus the total cost of the divisional organisation comes to about Rs. 45 lakhs a year, reckoning 50 divisions in British India.

37-16. Hence, for British India as a whole, the cost of the extension staff amounts to about Rs. 11 crores a year or a crore of rupees a year for an imaginary standard-sized province. Later when the divisional organisation can be replaced by a district organisation and the circle supervisor by a circle inspector, the tahsil inspector being dispensed with, the cost will be Rs. 4 crores for the district staff, Rs. 3 crores for the circle staff and Rs. 3 crores for the village staff, or Rs. 15 crores in all.

37-17. *Recommendations.* (1) For extension work, the village must be tackled as a unit, having its own co-operative or other organisation to link up the experts with the cultivators.

(2) Each village should have its Village Guide, who may either be a whole-time Government servant or a part-time cultivator of the village.

(3) The extension staff, apart from the Village Guides, should be;

Each Union	— 1 fieldman	} OR {	Nil
" Circle	— 1 non-graduate demonstrator		— 1 mukaddam or 1 kamdar
" Tahsil	— 1 graduate inspector		— 2 inspectors
" District	— 1 Superintendent or Assistant Director		— 1 Superintendent or Asst. Director.
" Division	— 1 Deputy Director		— 1 Deputy Director

(4) In addition, a division should have a number of specialised agricultural assistants to deal with agronomy, soil, botany, entomology, mycology, horticulture, engineering.

(5) The extension staff should arrange for the improved seeds, fertilisers, implements, insecticides and fungicides required in their areas.

(6) Each divisional experimental farm should have its seed farm where pedigree seed can be multiplied initially. Further multiplication prior to general distribution should be done through A and B grade seed growers.

(7) Each circle should be provided with its seed store and store keeper for collecting, storing and distributing seed, as well as manures, implements and other requirements.

37-18. *Cost.* The cost of extension work in British India, exclusive of Village Guides, is estimated at Rs. 3 crores annually. The creation and utilisation of Village Guides on the scale proposed will cost another Rs. 8 crores a year. It must be remembered, however, that these Guides will serve not only the interests of agriculture and animal husbandry but also of all Government departments associated with the advancement and development of the village.

Education.

38-1. The policy in respect of agricultural education is one on which experts differ. So far as teaching agriculture in primary schools is concerned, the general opinion seems to be that this should be confined to "Nature Study". In respect of secondary education many would like to see small farms attached to all rural secondary schools, and an agricultural bias imparted there. Others pin their faith on special vocational post-secondary schools, where training is given for two years in Agriculture. Lastly, there are agricultural colleges which teach up to the degree course. Post-graduate training has to be obtained at the Imperial Agricultural Research Institute and at some agricultural colleges affiliated to Universities. In this connection more emphasis has to be laid on the teaching of Biology at Universities.

38-2. The question of Agricultural Education in primary and secondary will be left to the Education Department for the present. It is,

however, necessary to make arrangements to give training to village guides in agriculture and animal husbandry and also to impart practical training to farmers at government farms.

38-3. Vocational Agricultural Schools can serve a useful purpose in the intermediary stage in training agricultural demonstrators. Some agricultural experts, however, do not regard this training as adequate and prefer degree courses. For the present such schools will have to be maintained in order to train subordinate staff, especially for extension work. They would also be required for the training of laboratory technicians. Suitable curricula should be framed for the purpose.

38-4. As regards degree courses at colleges the first point that needs attention is the proper selection of students who are admitted to them. Those who have shown a bias for agriculture in secondary schools should be given preference. A larger number of students should be admitted than the maximum that can be employed, to allow for wastage and give scope for further selection. For the rest there should be a reasonable prospect of remunerative service.

38-5. The degree training imparted at a college should include all the subjects for which research staff at provincial headquarters has been suggested. An additional basic grounding in scientific principles would also be needed. At each college there should be a training farm where students can be taught to perform all agricultural operations with their own hands. The first duty of the college is to make students good farmers, with modern knowledge and having the technical and practical ability to apply that knowledge.

38-6. Universities should also be encouraged and helped to establish courses for agricultural training.

38-7. When, as at present, there is an acute shortage of staff, special arrangements have to be made for speeding up the training. Courses have to be recast and shortened to provide for intensive technical training in a much shorter period than that considered necessary in normal times. It is imperative to expedite this training, and, where necessary, to open special classes for this purpose. To provide suitable staff for certain types of work within the shortest time, it may be possible to cut short the period of training by taking science graduates from the Universities. For instance, if graduates in Botany and Chemistry are taken, they can be given a degree at an agricultural college in two years. Further, the normal four years degree course can be compressed into three years.

38-8. Arrangements must be made for post-graduate training and for sending abroad selected students, and workers, for higher training and to gain wider experience.

38-9. Arrangements also have to be made for the training of agricultural teachers. It is essential that those who teach workers who have to educate the people should know exactly how to impart knowledge. The extension workers should know how best to transmit knowledge to the cultivators.

38-10. *Recommendations.* (1) Emphasis must be laid on the teaching of biology in Universities.

(2) Special arrangements must be made at departmental farms and elsewhere for the training of Village Guides.

(3) Vocational schools can serve a useful function in training non-graduate supervisors and demonstrators.

(4) Special arrangements are also necessary for training large numbers of Mukaddams or Kamdars at agricultural colleges, divisional experimental farms and wherever suitable facilities can be arranged.

(5) Each Agricultural College should possess a Farm where full facilities can be provided for giving adequate instruction to students in practical farming operations.

(6) To expedite the supply of suitably trained technical staff of degree standard existing degree courses should be shortened immediately from four to three years. Existing graduates in Natural Science may also get a degree in

Agriculture after undergoing an intensive two years' course of study in Agriculture and its applied sciences.

(7) Suitably selected departmental officers and University graduates in agricultural sciences should be sent abroad for post-graduate study and training. Increased facilities for similar study should also be arranged within India itself, at centres such as the Imperial Agricultural Research Institute and the Imperial Veterinary Research Institute.

38-11. *Cost.* If 40 provincial departmental officers of the younger generation, in addition to 100 carefully selected graduates, are sent abroad annually for a period of two years' post-graduate study, the annual cost would amount to about Rs. 25 lakhs. This rate of expenditure could be considerably reduced after a few years.

Educational Staff

39-1. The College should be under a whole-time Principal. The heads of the different scientific research sections should be Professors. They would do some lecturing, but they would concentrate on research. There should be a Professor of Agricultural Economics at each Agricultural College.

39-2. The usual staff of Assistant Professors, Lecturers and Demonstrators, who would be appointed, would be responsible for the greater part of the teaching, but should have sufficient free time to do some research work also. It may be possible to recruit some of them from the provincial research and extension sections for definite periods after which they will return to their normal work. In any case the teaching staff have to be properly trained for their work and arrangements for having an adequate number of trained teachers should be made immediately. Divisional and District Officers should lecture at Colleges on practical problems connected with extension work.

39-3. In other words, the present system prevailing in many colleges would need little change.

39-4. *Recommendations.* (1) An Agricultural College should have a whole-time Principal.

(2) The superior staff of an Agricultural College should include a Professor of Agricultural Economics.

(3) Heads of Sections should be Professors who would do some teaching but whose main function would be research. Most of the teaching would be done by Assistant Professors and Lecturers.

(4) There might be periodic exchanges of short duration between teaching and research officers, in order to keep both sides up to date.

(5) Deputy Directors of Agriculture should give courses of lectures at Agricultural Colleges on the practical aspects of provincial extension work.

39-5. *Cost.* The annual cost of an Agricultural College, catering for 200 degree students and for shorter courses, and including a students' farm, would amount to Rs. two lakhs. For all-India there would be need for 10 such colleges, which would cost Rs. 20 lakhs annually.

Provincial Headquarters.

40-1. In addition to the provincial research station, the provincial college and provincial extension staff, each province will need some additional staff at headquarters.

40-2. *Recommendations.* (1) The Director of Agriculture should have two Joint Directors—one for Extension and one for Research and Education. The latter post might be combined with that of the Principal of the College. The Director of Agriculture must invariably be a highly experienced officer possessing the highest technical knowledge of the subject.

(2) Adequate clerical and accountant staff must be provided. In large departments, there may have to be an officer of the status of a Deputy Director for controlling the establishment and another for dealing with financial matters.

40-3. *Cost.* The cost of the headquarter staff may be estimated at Rs. 5 lacs this works out at 30 lakhs of rupees a year.

Summarised annual cost of Federal and Provincial Research and of Extension and Education

41-1. The total financial implications of the Plant Husbandry proposals for British India may be summarised as follows:—

(a) Federal Organisation, consisting of, Headquarters, Research Institute and Commodity Research Stations	Rs. 1,30 lakhs
(b) Grants to Universities, provinces, etc. for research, extension and other purposes	Rs. 75 „
(c) Scholarships and grants for post-graduate study	Rs. 25 „
(d) Provincial headquarters staff	Rs. 30 „
(e) Provincial headquarter research stations and divisional experimental farms	Rs. 60 „
(f) Propaganda and demonstration	Rs. 60 „
(g) Agricultural Education	Rs. 20 „
(h) Provincial Extension Staff of all grades	Rs. 3,00 „
(i) Village Guides	Rs. 8,00 „

Thus, the total recurring cost of Federal and Provincial agricultural education, plant husbandry research and extension will be about Rs. 15,00 lakhs per annum.

41-2. It must, however, be borne in mind that these figures represent neither the minimum nor the maximum requirements. They also make no provision for capital expenditure. If money is not available, the proposed staff and work will have to be cut-down automatically and progress will be delayed. Again, research is not static; new ideas come up, new sciences develop and new methods and technique are evolved from time to time. It is, therefore, impossible to foresee future requirements. All that has been attempted in this note is to indicate very roughly what the needs are in existing circumstances.

41-3. It may also again be made clear that the suggestions made for the provinces would not apply to any particular area in its entirety. They will have to be modified from tract to tract to suit the size and finances of the province and other local conditions.

CHAPTER VI—ORGANISATION : ANIMAL HUSBANDRY.

Scope of Organisation

42-1. Living things are commonly divided into Plants and Animals. The pure sciences dealing with them are respectively Botany and Zoology, while the two combined constitute Biology. There is, however, no such clear distinction on the applied or practical side. The word Agriculture is sometimes used in its restricted sense of crop cultivation; but it is also commonly used now to include both Agriculture proper and Animal Husbandry. In many provinces the care and maintenance of farm animals, their feeding and their breeding are looked after by the Department of Agriculture, while the health and treatment of animals are the charge of the Veterinary Department. The logical division is into a department of Plant Husbandry, and one of Animal Husbandry.

42-2. There is a good deal of objection to this division from those in charge of Agriculture. They point out quite rightly that animals are an integral part of farming and cannot be separated from cultivation. They also urge, equally correctly, that the veterinary staff are not qualified to look after animal breeding and feeding. But it is open to question whether the Agricultural staff are any better qualified. The idea of an Animal Husbandry Department is to have a staff that will be qualified to deal with all aspects of animal husbandry.

42-3. The Animal Husbandry staff would naturally have to work in close collaboration with the staff on the Plant Husbandry side, as each is complementary to the other.

42-4. There may, however, be difficulties at present in having one department dealing with animal breeding, nutrition and health. The important point, however, is not whether animal breeding and/or nutrition is to be controlled by

the Agriculture Department or by the Veterinary Department, but that this work should be properly attended to by trained staff.

42-5. As is the case of Agriculture, the organisation needed may be considered under three heads, *viz.* Research, Extension and Education.

Research

43-1. As compared with plant husbandry, very little research in animal husbandry is in progress in provinces and States outside the central institutes or schemes financed by the I. C. A. R. Yet the scope for such research is enormous.

43-2. The federal organisations would be similar to those contemplated in the case of agriculture, *viz.*, a Federal Animal Husbandry Institute for scientific research and a number of commodity research stations for research on all aspects of a particular commodity. These are referred to in the following two sections.

43-3. So far as the Provinces are concerned, there are a number of government farms where breeding is carried out. But scientific principles of genetics have not yet been studied properly. There is little research on nutrition. It is necessary to take up research work at these farms in accordance with a coordinated plan of work. This is further referred to in Section 46.

The Federal Animal Husbandry Research Institute

44-1. The Imperial Veterinary Research Institute is in two blocks, one at Mukteswar in the hills; the other at Izatnagar, near Bareilly. Though it is called a Veterinary Institute, it has started developing into an Animal Husbandry Institute. It has a separate section for Animal Nutrition, and is expected shortly to have a section for Animal Genetics. It also has a Poultry section dealing with poultry breeding, feeding and disease. On the Veterinary side there are sections for (1) Pathology and Bacteriology (including virus diseases), (2) Veterinary Zoology, with branches for Helminthology, Protozoology and Entomology, (3) General Disease Investigation and (4) Biological Products. At Mukteswar and Izatnagar there are certain Service sections, dealing with office, estate, medical, veterinary and engineering, but all these sections are not fully developed at both places. There are also special schemes financed by the Imperial Council of Agricultural Research for dealing with (1) Tuberculosis and Johne's disease, (2) Foot-and-mouth disease, (3) Defects of Hides and Skins, (4) Artificial Insemination, (5) Life-history of certain helminth parasites, (6) Alkali treatment of straws, (7) Nutritive value of Vanaspathi. Schemes just completed are (1) Contagious abortion, (2) Poultry diseases, (3) Nutritive value of molasses, (4) Warble-fly damage to hides. Schemes sanctioned but not yet started are: (1) Anaerobic infections of animals, (2) Nutritive value of indigenous leafy fodders.

44-2. The general plan of research should be that the Institute should confine itself to basic research on problems of Animal Nutrition, Genetics and Disease. Poultry work should constitute a separate Institute, similar to the Dairy Institute.

44-3. For Animal Nutrition research, the Imperial Veterinary Research Institute has a Sectional Head, two class I officers (a Physiologist and a Pathologist), three class II officers and 10 assistants. The Nutrition section of the Federal Animal Husbandry Research Institute should perhaps have six subsections:

- (1) an analytical chemist in Class II with three research assistants for general routine analytical work,
- (2) a biochemist in Class I with one Class II officer and two assistants for general work on the biochemistry of foods, vitamins, animal tissues.
- (3) a physiologist in Class I with one Class II officer and two assistants for metabolism work, work on hormones, blood, urine,
- (4) a pharmacologist in Class I with one Class II officer who has specialised in organic chemistry and two assistants for studying the pharmacology of indigenous Indian drugs, and plant toxicology,

(5) a subsection of respiration calorimetry with one Class I, one Class II and three assistants for study of basal metabolism of large animals and the energy value of Indian feeding stuffs,

(6) a pathologist in Class I with one Class II officer and one assistant for investigating the pathological conditions associated with nutritive deficiencies.

These subsections would be under the Sectional Head who would be responsible for guiding the work at the Institute and correlating it with work in the provinces and States, in which there may be, for the present, four substations for applied nutrition work in the field. Each substation may have one Class I officer, one Class II officer and three assistants for work on local fodders and the general study of local nutrition problems.

44-4. The Animal Genetics section has not yet been constituted, though a Geneticist has recently been appointed. There is much to study, but it is largely long-range research. The Section may be divided into 4 subsections:—

(1) a Class I geneticist specialising in cattle and horses, two Class II officers specialising in sheep and goats and in poultry respectively, and three Assistants. This subsection will study inheritance factor, such as those for milk, wool, draught, disease resistance, etc., and the influence of different feeds on these factors;

(2) a Class II officer and two assistants for studying the physiology of reproduction in Indian animals;

(3) a Class I biochemist with a Class II officer to act as endocrinologist and two assistants for study of glands, sex stimulating hormones and introducing artificial insemination;

(4) one Class II officer in charge of the Mukteswar and Izatnagar dairies, with the necessary subordinate staff at each place.

The Sectional Head will also co-ordinate work in the provinces and States.

44-5. The Disease side of the Imperial Veterinary Research Institute is fairly well developed, but a number of items of work which at present are financed by the Imperial Council of Agricultural Research should be absorbed in the general work of the Institute. At present Disease falls into four sections, but these may be reduced to three as follows:—

(1) Pathology and Bacteriology.

Within this section there may be 5 sub-sections as follows:—

(a) General Diseases.

Hitherto this has been a separate section, but its work would be more effective if it were brought under the one Sectional Head. One Class I, one Class II officer and two assistants will suffice and they will work not only in the Institute but also in the field in co-operation with Disease Investigation Officers.

(b) Bacteriology.

Owing to the importance of bacteria as causing diseases of animals, there should be two Class I officers, one Class II officer and three assistants (including one for the Director, if he happens to be a bacteriologist).

(c) Viruses.

One Class I officer with one Class II officer and two assistants. Although viruses are of great importance in India, their study, as in the case of General Diseases, should be placed under one Sectional Head.

(d) Pathology (Morbid Anatomy).

One Class II officer and one assistant.

(e) Biochemistry.

One Class II officer and one assistant for investigating the biochemistry of bacteria.

(2) Veterinary Zoology.

This section may be sub-divided as at present into Helminthology, Entomology and Protozoology, each with one Class I and one Class II officer and two assistants, the whole under one Sectional Head.

(3) Biological Products.

This is a manufacturing section for vaccines, sera, etc. Research work connected with these products may continue to engage the attention of the Pathology and Bacteriology Section. Since biological production is likely to pass more and more into the hands of industrial firms, there is urgent necessity for a *Standards* Laboratory, so that a sub-section for this purpose may be added to the Biological Products section consisting of one Class I bacteriologist, one Class II chemist and two assistants. On the Production side a similar staff will suffice, but two extra assistants are required to cope with the work. The whole will be under a Sectional Head.

44-6. Apart from the foregoing sections whose functions are almost entirely research, there must be Service sections devoted to administration, estate, medical, veterinary, engineering, library, statistics. Some of these Service sections would also be expected to conduct some research.

44-7. The Institute should be in charge of a Director assisted by a Joint Director, who may also hold one of the research posts in the Institute.

44-8. The pay of the staff should be similar to that recommended for the Federal Agricultural Research Institute.

44-9. The Institute, like its sister agricultural institute, should be attached to the Imperial Council of Agricultural Research. It is not necessary to repeat the reasons already given.

44-9. *Recommendations.* (1) The Institute should be attached to the Imperial Council of Agricultural Research.

(2) It should be under the charge of a whole-time Director, assisted by a Joint Director who may be a senior research officer.

(3) The Institute should confine its work to basic research on animal nutrition, genetics and disease.

(4) The organisation of the Institute should consist of five principal sections for nutrition, animal genetics, disease, veterinary zoology, and biological products, supplemented by a number of service sections. Each principal section should be divided into an appropriate number of sub-sections to cover each aspect of the science with which it deals.

(5) For the present there should be four nutrition research substations in the provinces and States.

(6) The staff of the five principal sections and of the substations will consist, in addition to the five Sectional Heads, of about 20 Class I, 25 Class II officers and about 55 assistants.

44-10. *Cost.* The present annual recurring cost of the Institute is about Rs. 12 lakhs. With the additions proposed it may be estimated at Rs. 20 lakhs a year. Capital expenditure will be additional.

Commodity Research Stations

45-1. Perhaps the most important commodity research station is that existing for Dairying, since milk and milk products occupy the first place after food grains in the diet of the people. It is financed at present by the Central Government at a cost of Rs. 3 lakhs a year. In addition, it receives grants for specific schemes to the extent of Rs. 1 lakh from the Imperial Council of Agricultural Research. In accordance with the general plan visualised, this station should come under an Indian Central Milk Committee.

45-2. The staff of the Dairy Institute consists at present of a Director (who is a Technologist), a Bacteriologist, a Chemist, a Dairy Husbandry officer, a Superintendent and an Assistant Bacteriologist. Allowing for the additional staff that is necessary for its proper expansion, its cost may be put down at Rs. 10 lakhs a year.

45-3. The Poultry Institute is at present a Section of the Imperial Veterinary Research Institute. Its staff consists of a Sectional Head, two Class I officers (a Pathologist and a Biochemist) and a number of assistants and farm overseers. This Section should form a separate Poultry Research Station under an Indian Central Poultry Committee.

45-4. A station along similar lines is needed in respect of Wool and another for Hides and Skins.

45-5. A Fisheries station to deal with both marine and fresh water fish is also necessary. This is estimated to cost 10 lakhs of rupees a year. It should be under an Indian Central Fish Committee.

45-6. Some of these stations will need substations. These are best entrusted to the provinces and States; the programme of work for each, however, should be laid down by the Central Committee concerned.

45-7. *Recommendations.* (1) The present Dairy Institute should be suitably expanded and should come under an Indian Central Milk Committee, as a Dairy Research Station.

(2) The present poultry section of the Imperial Veterinary Research Institute should be expanded into a Poultry Station under an Indian Central Poultry Committee.

(3) Similar stations and Central Committees are required for Wool, for Hides and Skins, and for Fisheries.

45-8. *Cost.* The cost of these Stations and their Central Committees will amount to about Rs. 35 lakhs per annum.

Federal Headquarters

46-1. The Animal Husbandry Organisation at Federal Headquarters would be very similar to that visualised for Agriculture. In addition to the Federal Animal Husbandry Research Commissioner there should be Advisers in respect of such aspects as Extension, Dairies, Fisheries, Poultry. A Federal Animal Husbandry Service and bureau would also have to be constituted.

46-2. *Cost.* The annual cost of the headquarters organisation would be about Rs. 3 lakhs. Provision for grants to provinces and States, scholarships, etc., is included in items shown in para 41-1, (b) and (c).

Provincial Farms

47-1. For each recognised breed there should be at least one stock-breeding farm where a nucleus herd of that breed can be maintained. The farm would produce male stock for distribution to approved breeders. It would ascertain the maximum potentiality of the breed, e.g., for both milk and draught, in the case of cattle. It would determine what particular qualities to breed for and in what directions the breed can best be developed.

47-2. At least one farm in each province or State should also take up live-stock research in certain directions. It should serve as a centre for artificial insemination. It should carry out practical feeding experiments with fodders available in the tract and should assess their economic values. It should ascertain the capacity of a breed when fed on local fodders. It should try out new methods of disease control, such as those evolved in connection with rinderpest, abortion, mastitis, etc., before those methods are recommended by the extension staff to stock owners.

47-3. As there are 32 recognised breeds of cattle, 7 of buffaloes and 18 of sheep, it appears that at first some 60 farms are needed in the country. Farms for important breeds would need about 1,200 acres of land each, either as one unit or as several proportionately smaller units.

47-4. Regional dairy farms, as distinct from breeding farms, should also be established.

47-5. The staff required for such a farm may be one officer of the status of an Assistant Director, two Class II officers, (one veterinary officer for stock and one agricultural officer for fodder), in addition to the necessary number of assistants and subordinates. There should also be a geneticist and a nutrition officer at each farm where research is taken up. The dairy farm will naturally have a dairy specialist as the officer-in-charge.

47-6. *Recommendations.* (1) A stock-breeding farm of about 1,200 acres, or a greater number of proportionately smaller size, should be established for the maintenance of a nucleus herd of each recognised breed. To cover all breeds of cattle, buffaloes and sheep about 60 farms would be needed.

(2) Each province or State should establish at least one farm for research on matters affecting animal nutrition and health.

(8) Regional dairy farms should also be established.

47-7. *Cost.* Very roughly it may be said that the cost of a livestock research farm would be rupees one lakh a year, while each of the other stock-breeding farms would cost half a lakh yearly. Ten of the former and fifty of the latter would thus cost Rs. 35 lakhs.

Hospitals and Dispensaries

48-1. At present in most areas, the main work of the veterinary staff is at hospitals and dispensaries. At every district headquarters there should be a well-equipped hospital in charge of a veterinary surgeon. He may have to be assisted by an assistant surgeon and a compounder, where the work is heavy; elsewhere a compounder or dresser, in addition to the ministerial and menial staff, would suffice.

48-2. In each district there are usually 4 or 5 tahsils or subdivisions. At the headquarters of each such tahsil, there may be a veterinary dispensary in charge of a veterinary assistant surgeon. Where there is not enough work for a full time officer, the assistant surgeon should have certain touring duties, the routine work being carried on during his absence by a compounder or dresser. When on tour, he should attend a particular place on a fixed day of the week.

48-3. *Recommendations.* (1) At each district headquarters there should be a well-equipped veterinary hospital, in charge of a veterinary surgeon.

(2) At the headquarters of each tahsil or sub-division there should be a veterinary dispensary, in charge of an assistant veterinary surgeon.

48-4. *Cost.* The cost of running 240 hospitals and 1,000 dispensaries would be about Rs. 40 lakhs a year.

Extension

49-1. The extension work includes not only the treatment of diseases and their prevention, but also includes guidance on the proper maintenance, feeding and breeding of animals and on the best methods of increasing the quantity and quality of the animal products and their proper marketing. It is the business of the extension staff to carry the results of research to the stock-owners and to bring the problems of stock-owners to the notice of the experts and research workers for a solution. This staff has to work in close collaboration with the experts on the one hand and the stock-owners on the other.

49-2. The ultimate organisation to be aimed at is that there should be a village guide for each village or group of villages. One such guide per village will suffice for both agriculture and animal husbandry. For a Union of 25 villages or so there should be a stockman. Four Livestock Inspectors, at least two of whom would have veterinary qualifications, with the help of stockmen in the Unions, should be able to attend to all animal husbandry problems in each tahsil. When more staff is available, it should be possible to have two Livestock Inspectors for each circle.

49-3. For each district there should be a District Livestock Officer who should be a veterinary graduate. He should be in charge of the District Veterinary Hospital and should have a Veterinary Assistant Surgeon to assist him.

49-4. Most provinces have divisions consisting of 4 or 5 districts. A division may be in charge of a Deputy Director of Animal Husbandry, who may be either a senior Class II or a Class I officer.

49-5. The total staff for British India may be roughly estimated at 20,000 stockmen, 4,000 Inspectors, about 500 District Livestock Officers, with an equal number of assistants, and 50 Deputy Directors of Animal Husbandry.

49-6. *Recommendations.* (1) There should be a village guide for each village or group of villages.

(2) For each union there should be a stockman.

cultural lime, which is a major requirement of land for optimum production in the United Kingdom,

(iv) assist financially in launching a scheme for the production, multiplication, storage and distribution of improved seed. The capital cost involved in the establishment of seed farms and the construction of seed stores may go up to 4 crores of rupees. (This is distinct from the cost of erection of grain stores),

(v) help in finding rural credit, *e.g.*, for the working capital of seed stores; for the orderly marketing of agricultural and animal husbandry produce and for land, livestock and dairy improvements,

(vi) help financially in (a) preparing and (b) carrying out schemes for the reclamation of waste lands and for anti-erosion work,

(vii) take steps to ensure concerted action, so that the execution of beneficial works may not be held up, in cases where an irrigation or an anti-erosion project concerns more than one unit (Province and State),

(viii) acquire legislative powers, where a majority of those concerned agree to the adoption of measures calculated to benefit the community as a whole, to compel an objecting minority in respect of such matters as:—

(a) the use of improved seed,

(b) the adoption of measures for pest and disease control,

(c) the carrying out of land improvements, such as bunding,

(d) the consolidation of cultivation or of holdings,

(e) the control of grazing,

(f) the castration of scrub bulls,

(g) the removal of cows and buffaloes from towns,

(h) the establishment of regulated markets,

(i) the prescription and adoption of standard contracts and grades for agricultural and animal husbandry produce,

(j) the licensing of traders,

(k) the cleaning of silt from tanks,

(l) the repair of bunds.

(ix) maintain buffer stocks and should control exports, imports and internal distribution, where necessary,

(x) not regard means of communications and transport under its control as commercial concerns designed to make profits but as public services designed to further the welfare of the people.

(xi) make every effort to develop hydro-electric power, specially in order to develop rural industries.

(xii) take up industrial development simultaneously with the development of agriculture and animal husbandry, as the two are interdependent.

(xiii) legislate against systems of farming that stand in the way of improving agriculture and animal husbandry.

(NOTE. In this Section the word "Government" means the Central, Provincial or State Government, according to which of them is concerned in the execution of the particular recommendation.)

Order of Priority

54-1. The primary aim of agriculture and animal husbandry development is to find the fullest employment for cultivators, to promote their welfare, to increase production and to secure an equitable distribution of their products. The first task is to provide adequate nutrition for the whole population and fodder and concentrates for the cattle. Next, a sufficient quantity of raw materials has to be produced to supply the industrial needs of India. Again, commodities have to be produced for export, to enable the country to pay for the import of machinery and other capital requirements. A great increase in production, particularly of milk, vegetables and oilseeds, is required.

54-2. The most important items needed to attain these objectives are men, money and materials. The provision of the necessary finance is a matter for Government and in normal times, if money is forthcoming, materials can always be secured. But men—trained men—cannot be obtained at a moment's notice and practically no development can be carried out satisfactorily without them.

54-3. *Training.* Hence, the first item in any programme of development must be the training of the staff required. It has to be remembered, however, that it is no use training men if money is not forthcoming in order to employ them usefully. At present it is necessary to adjust work to the number of trained men available. Later, it will be equally necessary to adjust the training of the men to the scope for their employment. In other words, before training is undertaken on a big scale, it is advisable to have a rough idea of the number of men likely to be required for each type of work.

54-4. The general plan of work, sketched out in the foregoing pages visualises (i) the undertaking of a number of technical surveys, (ii) the expansion of the Federal Institutes, (iii) the establishment of a number of commodity research stations, (iv) the starting of a large number of experimental and cattle farms and (v) the 'strengthening' of the provincial staff for research, extension and education. On this basis, it will be necessary to work out for the Centre and for each province what staff will be needed and to arrange for the training of the necessary numbers.

54-5. For the proper training of many of the higher staff it will be necessary to send men abroad, so that they can obtain a wider outlook. If possible also, arrangements should be made for the temporary exchanges of Indian workers with those of other countries. Additional facilities for post-graduate instruction in India must be provided. For the training of graduate assistants in the necessary numbers existing agricultural colleges need to be enlarged and additional colleges to be established. To make available in a reasonable time the thousands of non-graduate assistants, mukaddams and other necessary subordinates, agricultural colleges, agricultural schools and selected departmental farms must be utilised to their full capacity.

54-6. The training programme must work out the number of required men of each category and the time within which they must become available. There may be a further problem of inadequacy of trained teachers in some places. If so, the training of the necessary teachers must precede the training of the future research and extension staff. This might delay the availability of the latter by a further two years and, in the meantime, only the normal output of the various institutions would be forthcoming.

54-7. *Surveys.* Most people dislike the idea of surveys, but they are essential preliminaries to development. Information must be collected in the first instance concerning the location of the available waste lands and why they are not cultivated, before schemes for waste land reclamation can be prepared. Similarly, development schemes for land erosion control and the construction of dams for irrigation have to be preceded by surveys. Soil studies have to be taken up if farms are to be properly sited, so that the results obtained at them may be applicable to wide areas. All this work must be undertaken as soon as possible, so that suitable schemes for development can be drawn up.

54-8. *Improvements.* It is for each province and State to review its own condition and to determine what items should have priority. For India as a whole, the following order of priority is suggested:—

A. (i) Irrigation by the construction of tanks, wells and canals and the maximum conservation and utilisation of the water resources of the country.

(ii) Manure, for tracts where adequate rainfall or irrigation is available. Manufacture of ammonium sulphate in adequate quantities in India is a pressing need.

(iii) Land improvement, especially by the construction of contour bunds, afforestation, fuel supply and the digging of drainage cuts.

(iv) Seed, including the establishment of seed farms and stores.

(v) Husbandry for which experimental farms in typical areas are needed to ascertain the best cultural practices.

(vi) Grading up of cattle for milk and draught, the development of dairying and the provision of farms for the purpose.

B. (vii) Provision of implements, tractors and cheap power.

(ix) Construction of cold stores.

(x) Supply, at cheap rates; of insecticides, fungicides, fumigants, drugs vaccines, sera, etc.

54-9. *Staff and stations.* Here again, it is primarily for the provinces and States to determine their own order of priority and the stages by which the ultimate goal can be attained. The expansion of the existing Institutes and the starting of the necessary Commodity Research and Experiment Stations would be largely for the Centre. It is suggested that one of the greatest needs in extension work is the attachment of scientific assistants to each division in order to maintain the link between field work and research. Another essential is the laying out of experiments on a wide scale to ascertain the best cultural schedule (including varieties, manure and irrigation) for each soil-climate complex.

Financial Implications

55-1. The full financial implications of the proposals are difficult to work out at the present stage. Until surveys have been completed and development schemes have been prepared, it is not possible to estimate what the final possibilities for development in a number of directions are likely to be, or to visualise with any degree of accuracy the capital cost involved in executing those developments.

55-2. In this memorandum, on the non-recurring side, an expenditure of a crore of rupees is visualised on the conduct of preliminary surveys and the preparation of detailed plans for the development of water resources, the control of erosion and the reclamation of cultivable waste. The actual cost of ultimate construction work on the basis of these surveys can only be estimated roughly, and has been placed at 450 crores of rupees, whilst drainage and anti-waterlogging measures have been shown as costing a further 100 crores.

55-3. The capital expenditure for setting up the necessary farms for agricultural experiments, seed production and cattle breeding amounts to about 4 crores of rupees. The construction of wells, tanks, bunds and drainage cuts, together with the execution of anti-waterlogging measures, has been estimated at 230 crores. The installation of ammonium sulphate factories to produce the full requirements of this fertiliser may cost 40 crores. Grain and seed stores, and cold storage may involve an expenditure of 115 crores. Tractors and machinery will cost one crore. Provision for the hygienic production of milk in villages and its treatment for transport, as well as measures to promote the health of livestock in villages may account for nearly 30 crores.

55-4. The non-recurring expenditure on those items in which this aspect has been considered in this memorandum totals about 921 crores of rupees. But, apart from the fact that these figures are guesses, no provision at all has been included for many essential items, such as college, farm and veterinary hospital buildings and equipment. Again, the proposals themselves are not necessarily the last word in development. Many other items may have to be included subsequently.

55-5. In the light of the indications which this memorandum has given, however, it is perhaps reasonable to conclude that in the next 15 years the proper development of agriculture and animal husbandry in British India will involve capital expenditure of the order of 1,000 crores of rupees.

55-6. On the recurring side, it is possible to estimate the cost with a greater degree of probability, although the calculations for some items must necessarily be rough.

55-7. The Federal Headquarters Organisation, Federal Research Institutes and Central Commodity Committees and Stations are calculated to cost Rs. 1.88 lakhs annually. This becomes Rs. 2.13 lakhs, when provision is made for the post-graduate training abroad and in India of departmental staff and others to fit them for the many higher posts which will have to be created. To this there is to be added Rs. 75 lakhs for grants to Universities, provinces and States for research, extension and other purposes, thus making a total of Rs. 2.88 lakhs annually.

55-8. The annual cost of Provincial Agricultural and Animal Husbandry Headquarters is estimated to be Rs. 40 lakhs a year. Provincial Agricultural and Veterinary Colleges may involve another Rs. 40 lakhs. Veterinary hospitals will cost Rs. 40 lakhs more. Provincial farms for stock breeding, agricultural experiments, seed multiplication, etc., will require a provision exceeding Rs. 1 crore annually. The extension staff will necessitate an annual expenditure amounting to Rs. 5 crores. The system of Village Guides will cost Rs. 8 crores more annually. Maintenance charges on many of the capital works cannot be estimated at this stage, but they will involve a considerable sum annually.

55-9. On the recurring side those estimates which have been made in this memorandum total Rs. 24.87 crores. They are necessarily rough approximations in some cases, whilst they do not include provision for maintenance and running costs of some of the items in the plan. Further, as the plan is put into execution, additional unforeseen items of expenditure are likely to arise. It may be accepted, therefore, that the cost of the developments of agriculture and animal husbandry which this memorandum visualises, will amount to Rs. 25 crores annually. Of this total, the shares of the Centre and of the provinces will probably be about Rs. 8 crores and Rs. 22 crores a year, respectively.

55-10. Expressed otherwise, an annual expenditure of Rs. 25 crores on the development of agriculture and animal husbandry in British India represents an average of less than one rupee per acre on the present total area under cultivation, or of less than twelve annas an acre, if and when all the area now recorded as culturable waste can be brought under cultivation. Viewed in this light, the proposals should not be beyond the range of practical politics.